

# **TEKTRONIX®**

## **TR 502**

### **TRACKING GENERATOR**

## **INSTRUCTION MANUAL**

Tektronix, Inc.  
P.O. Box 500  
Beaverton, Oregon 97077

Serial Number \_\_\_\_\_

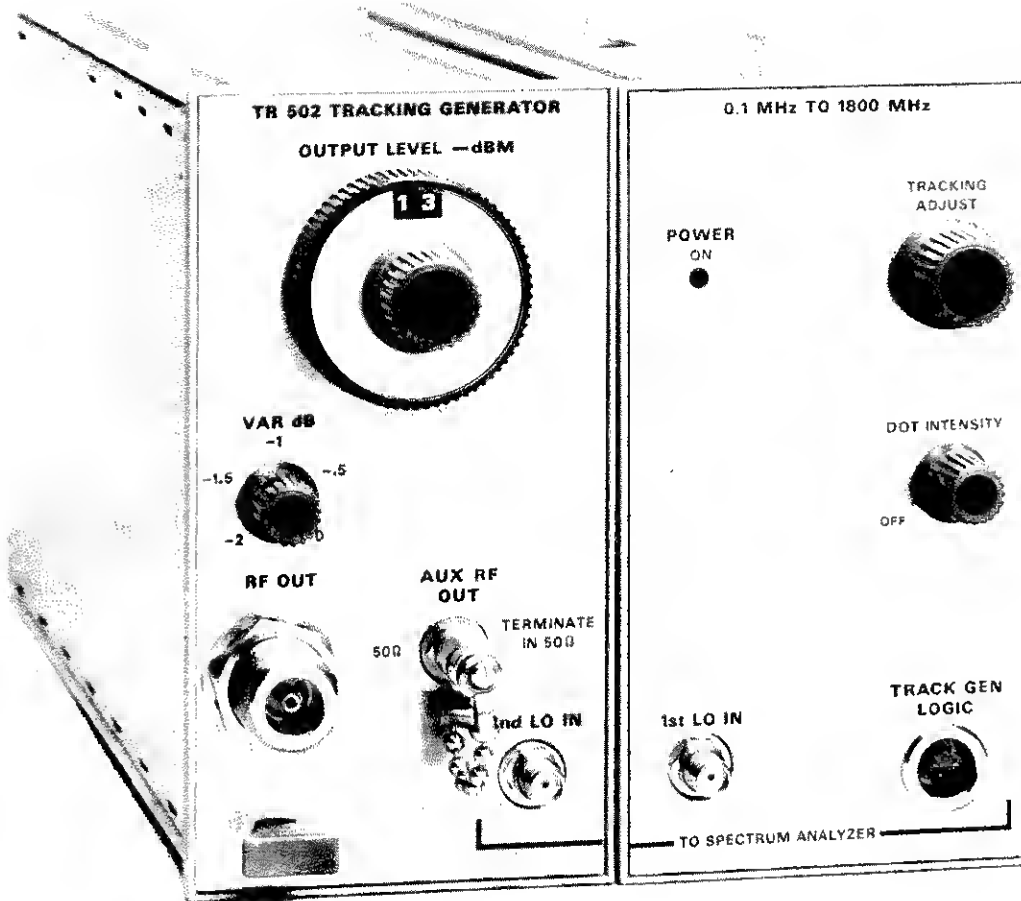


Fig. 1-1. TR 502 Tracking Generator.

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# GENERAL INFORMATION AND SPECIFICATIONS

## Introduction

The abbreviations, graphic symbols, and logic symbology used in the text and diagrams of this manual are in accord and based on ANSI Y1.1-1972, ANSI Y32.2-1970, and ANSI Y32.14-1973 (American National Standard Institute, 345 East 47 Street; New York, N.Y. 10017).

Change information has been integrated into the manual by goldenrod insert pages at the back of the manual and page revision. Original pages are identified by the symbol @ and revised pages are identified by a revision date in the lower inside corner of the page. If the serial number of your instrument is lower than the one on the title page, the manual contains revisions that may not apply to your instrument. History or backlog information all previously applicable to produced products with the updated data is integrated when the page or diagram is revised. The following describes the sections and information provided in this manual.

**Section 1—General Information and Specifications:** Contains instrument description, electrical specifications, environmental characteristics, accessories, installation, and repackaging for shipment instructions.

**Section 2—Operating Instructions:** Information relative to operating and checking the instrument operation.

**Section 3—Performance Check:** Procedure to check the operational performance and electrical specifications of the instrument. Two-part section provides an incoming inspection type check and a detailed electrical performance verification.

**Section 4—Calibration Procedure:** Describes test equipment setup and adjustment procedures required to calibrate the instrument.

**Section 5—Circuit Description:** Provides basic and general circuit analysis that may be useful when servicing or operating the instrument.

**Section 6—Maintenance Instructions:** Describes routine and corrective maintenance procedures with detailed instructions for replacing assemblies, sub-assemblies, and individual components. An exploded drawing is part of Section 10.

**Section 7—Options and Modifications:** Provides data on production options available.

**Section 8—Electrical Parts List:** Provides information necessary to order replaceable parts and assemblies related to the electrical functions of the instrument.

**Section 9—Diagrams:** Provides functional block diagram and detailed circuit schematics. Located adjacent to the diagram (usually on the back of the preceding diagram) are pictorial layout drawings which show sub-assembly and component locations. Voltage and signal level information, if applicable, is included to aid in troubleshooting.

**Section 10—Mechanical Parts List, Exploded Drawings and Accessories:** Provides information necessary to order replaceable mechanical parts. The Parts List is cross-referenced to the Electrical Parts List when appropriate. Exploded drawing shows sequence of assembly and identifies assemblies.

**Changes and Corrections:** Provides updating information for the manual in the form of inserts. These inserts are incorporated into the manual text and diagrams when the manual is updated.

## Description

The TR 502 Tracking Generator operates with the 7L13 or 7L12 Spectrum Analyzer to provide a calibrated rf signal for swept frequency applications from 100 kHz to 1.8 GHz. The output frequency of the TR 502 can be adjusted to track the spectrum analyzer frequency within 10 Hz. The TR 502, a two-wide unit compatible with the TM 500 Modular Series instruments, is normally used with the TM 503 (Option 7) Power Module. This permits the optional use of a digital counter such as the DC 502 Option 7. A bright dot, on the spectrum display, identifies the frequency location on the sweep that is indicated by the counter. Higher range counters to 1.8 GHz can be used by connecting their input to the TR 502 AUX RF OUT connector.

## ELECTRICAL CHARACTERISTICS

The following characteristics and features apply to the TR 502 and TR 502/7L13 Spectrum Analyzer system. They are applicable over the environmental specification limits for the TM 500- and 7000-Series mainframes.

Frequency Range:	The TR 502 tracks the 7L13 tuned input frequency from 100 kHz to 1.8 GHz.
Output Level:	
Maximum Output Position (0 dBm):	0 dBm $\pm$ 0.5 dB.
Range:	0 to -59 dBm in 10 dB and 1 dB steps.
Relative Level Accuracy:	$\pm$ 0.2 dB/1 dB step to a maximum of $\pm$ 2.0 dB. A front panel control provides an additional 2 dB of attenuation.
Output Impedance:	50 $\Omega$ nominal, VSWR is 2:1 or less to 1.8 GHz.
Flatness:	
TR 502:	Within $\pm$ 0.5 dB, from 100 kHz to 1.8 GHz.
TR 502/7L13 System:	Within $\pm$ 2 dB, from 100 kHz to 1.8 GHz.
Dynamic Range:	
TR 502/7L13 System:	110 dB or more.
Residual FM (peak to peak):	
TR 502:	1 Hz or less.
TR 502/7L13:	10 Hz or less.
Auxiliary Output:	0.1 Vrms minimum, into 50 $\Omega$ load.
Spurious Output:	
Harmonic Content:	20 dB or more below the carrier.
Non-Harmonic Content:	40 dB or more below the carrier.

## ENVIRONMENTAL CHARACTERISTICS

This instrument will meet the electrical characteristics over the environmental limits of the TM 500-Series Test and Measurement System Power Module. Complete details on test procedure, including failure criteria, etc., can be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

### Operating and Storage Requirements:

Operating Temperature Range:	0°C to +55°C.
Storage Temperature Range:	-54°C to +75°C.

## ACCESSORIES

### Standard Accessories

Two coaxial cables, 50 $\Omega$	
28.5 inches	012-0649-00
Logic Interface Cable	012-0648-00
Adapter, "N male to BNC female"	103-0045-00
Retainer Plug-in	343-0604-00
Manual, Instruction	070-1735-00

### Optional Accessories

Adapter, SMA Male to BNC Female	015-1018-00
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## INSTALLATION

### Initial Inspection

This instrument was inspected both mechanically and electrically before shipment. It should be free of marks or scratches and electrically meet or exceed all specifications. To confirm this, inspect the instrument for physical damage incurred in transit and test the electrical performance by following the Operating Instructions in Section 2 and Performance Check Procedure in Section 3. If there is damage or deficiency, contact your local Tektronix Field Office or representative.

### Installation

This instrument may be shipped installed in the TM 500 Series Power Module and ready for use as a bench instrument or it may be shipped as an individual unit. If shipped as an individual unit, install the TR 502 into the TM 500 Power Module as illustrated in Fig. 1-2. After installation connect the TM 500 to a suitable power source and proceed as directed in the Operations section of this manual.

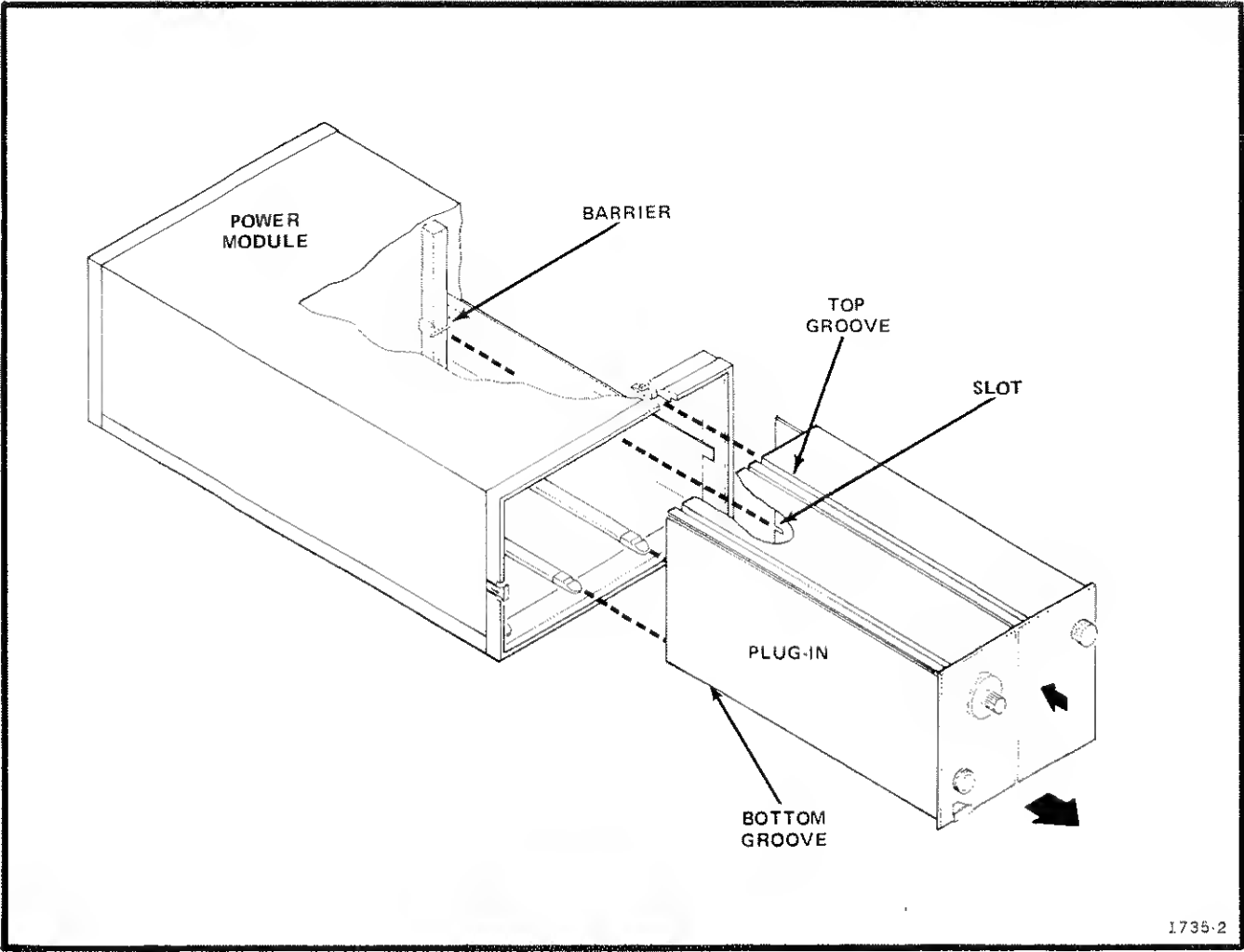


Fig. 1-2. Plug-in Module Installation/Removal.

### REPACKAGING FOR SHIPMENT

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or replacement, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted, plus complete instrument serial number and a description of the service required.

Save and re-use the shipping container your instrument was shipped in. If the original packaging is not available or unfit for use, repackage as follows:

1. Obtain a shipping container made of heavy corrugated cardboard or wood with inside dimensions of no less than six inches more than the instrument dimensions; this will allow room for cushioning. Refer to Table 1-1 for carton test strength requirements.

2. Wrap the instrument in heavy paper or polyethylene sheeting to protect the finish of the instrument. Protect the front panel with urethane foam or cardboard strips.

3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing three inches on all sides.

4. Seal the carton with shipping tape or an industrial stapler.

TABLE 1-1

Gross Weight (lb)	Carton Test Strength (lb)
10—30	275
30—120	375
120—140	500
140—160	600

If you have any questions, contact your local Tektronix Field Office or representative.



# OPERATING INSTRUCTIONS

## Introduction

This section describes the function of the front panel controls and connectors, installation of the TR 502 into the TM 500-Series mainframe, interface connections to the spectrum analyzer and frequency counter, adjustments required to calibrate the TR 502 to the spectrum analyzer, and how to use the tracking generator.

## About the Tracking Generator

The TR 502 Tracking Generator is a two wide plug-in unit for the TM 500-Series (Option 7) Power Modules. It operates with the 7L13 or 7L12 Spectrum Analyzer to provide a constant, level-calibrated rf signal source, that precisely tracks the spectrum analyzer input frequency from 100 kHz to 1.8 GHz. Signal output level is calibrated and adjustable from 0 dBm to -59 dBm in 1 dB steps. The Spectrum Analyzer/Tracking Generator system can be used to display frequency response of various devices such as filters, amplifiers, etc. that are connected between the tracking generator RF OUTPUT and the spectrum analyzer rf input connector.

When the TR 502 is installed in a modified three-wide or larger, power module, a frequency counter such as the DC 502 can be connected to the AUX OUT and used to accurately measure the frequency for any fixed position of span. When the analyzer is in the non-sweep mode, the TR 502 output is a cw signal and the counter reads continuously. If a DC 502 Option 7, or similar counter is used, the TRACKING GEN LOGIC is interfaced with the 7L13 Spectrum Analyzer so operational logic from the TR 502 controls the sweep function of the spectrum analyzer and the frequency counting of the counter. A dot is displayed at sweep center to indicate where and when the frequency count is taken.

The TR 502 is installed in the TM 500-Series mainframe by aligning the upper and lower guide rails with the plug-in compartment tracks and pushing the TR 502 into the compartment until the front panel is flush with the mainframe front panel. To remove, pull the release latch to disengage the locking mechanism and pull the unit out. See Fig. 1-2.

## Function of the Front Panel Controls and Connectors

The following is a description of the controls and connectors on the TR 502:

**OUTPUT LEVEL:** Selects 0 dB to 59 dB of attenuation in 1 dB steps of the calibrated output signal.

**VAR dB:** This control provides continuous output level adjustment over a range of 2 dB.

**DOT INTENSITY:** This control sets the brightness of the displayed frequency indicating dot when the TR 502 is used with a DC 502 Option 7, or equivalent frequency counter, and the TR 502/7L13 Spectrum Analyzer is operating in the sweep stop mode.

**TRACK ADJUST:** Adjusts the frequency offset between the TR 502 Tracking Generator output signal and the tuned input frequency of the spectrum analyzer.

## OUTPUT CONNECTORS:

**RF OUT:** A 0 dBm to -61 dB, 50  $\Omega$ , signal source with a frequency that tracks the spectrum analyzer. Output level depends on the setting of OUTPUT LEVEL and VAR dB controls.

**AUX RF OUT:** A source of the output signal for auxiliary test equipment such as a frequency counter. This output connector must be terminated in a 50  $\Omega$  load to maintain flatness.

## INPUT CONNECTORS:

**1st LO IN and 2nd LO IN:** These interface to the spectrum analyzer 1st LO and 2nd LO Output connectors.

**TRACK GEN LOGIC:** Interfaces operational logic between the tracking generator and the spectrum analyzer to operate the system with a compatible frequency counter.

## Operational Check and Calibration

The TR 502 plugs into and receives its power from a TM 500-Series mainframe. It operates with the 7L13 or 7L12 Spectrum Analyzer. The 1st and 2nd LO signal from the spectrum analyzer are applied, via coaxial cables, to the 1st and 2nd LO INPUT connectors for the TR 502. If the TR 502/7L13 system is used with a DC 502 Option 7 Digital Counter, a third cable interfaces between the TR 502 and 7L13 Spectrum Analyzer to supply the necessary logic data for the various counter and spectrum analyzer operating modes. This interface cable is used when a counter is part of the system.

## 1. Preliminary

a. Insert the TR 502 in a TM 500 power unit mainframe (TM 500 Option 7) and the spectrum analyzer (7L13) into a 7000-Series mainframe.

b. Using the coaxial cables, supplied with the standard accessories, connect the 1st and 2nd LO Output ports of the spectrum analyzer to the 1st and 2nd LO Input ports of the TR 502, then connect the RF OUT to the RF Input of the spectrum analyzer. If a frequency counter is used, connect the AUX RF OUTput of the TR 502 to the RF Input of the counter. Fig. 2-1 illustrates system hookup.

c. Set the spectrum analyzer Span/Div to Max, Resolution to 3 MHz, Display Mode to 10 dB/Div, Reference Level to 0 dBm, and switch on the power to all units.

d. Set the OUTPUT LEVEL of the TR 502 to -10 dBm and check for a level ( $\pm 3$  dB) across the spectrum analyzer display (100 kHz to 1.8 GHz).

## 2. Check Output Level

a. Change the spectrum analyzer Reference Level to 0 dBm. Set the TR 502 OUTPUT LEVEL and VAR dB controls for an output of 0 dBm (fully clockwise).

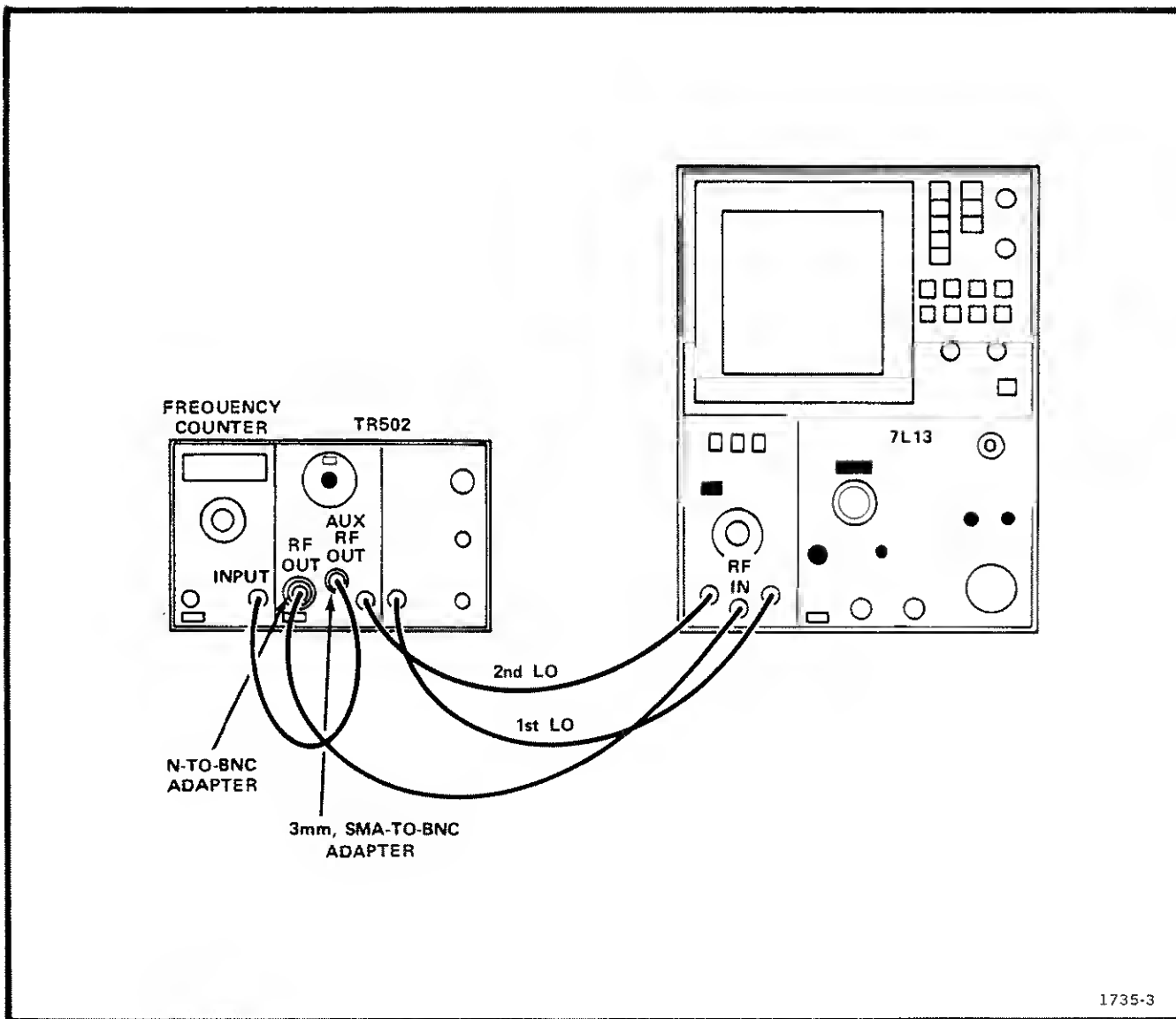


Fig. 2-1. TR 502/7L13 Spectrum Analyzer System with a Frequency Counter.



b. Decrease the TR 502 OUTPUT LEVEL to  $-50$  dBm in 10 dB increments and increase the spectrum analyzer sensitivity in 10 dB increments. Note that the display level remains constant.

c. Return the TR 502 OUTPUT LEVEL to 0 dBm, change the spectrum analyzer Freq Span/Div to 1 MHz and the Display Mode to 2 dB/Div. Adjust the spectrum analyzer Ref Var control or the TR 502 VAR dB control to set the display at some graticule division.

d. Decrease the TR 502 OUTPUT LEVEL in 1 dB steps and note that the display level decreases proportionately. Return the OUTPUT LEVEL and VAR dB control to 0 dBm.

e. Rotate the VAR dB control through its range and note that the display level decreases in accordance with the calibrated scale on the front panel. Return the control to its 0 dB position and/or the spectrum analyzer Ref Var control to Cal.

### 3. Tracking Adjust

This control adjusts the TR 502 output frequency to the input frequency of the spectrum analyzer.

a. Set the spectrum analyzer Reference Level to  $+10$  dBm and the Display Mode to 2 dB/Div. Set the TR 502 OUTPUT LEVEL and VAR dB controls for an output of 0 dBm (fully clockwise).

b. Decrease the spectrum analyzer Freq Span/Div towards 200 Hz while adjusting the TRACKING ADJUST control for minimum frequency offset. This corresponds to maximum response on the display.

#### NOTE

*If the TR 502 is used with a 7L13 Spectrum Analyzer the TRACKING ADJUST may run out of range at high resolution (3 kHz or less) settings because the IF in some early production 7L13 units may deviate a small amount from 105 MHz. If this occurs, notify or contact your local Tektronix Field Office or representative to correct this situation.*

### Measuring Frequency

The TR 502 features a sweep-stop operational mode that stops the sweep at center screen, centers the dot, instructs the frequency counter to take a frequency measurement, then allows the sweep to continue. Gate (count) time is determined by the phase lock mode of the analyzer. When the analyzer is phase locked, the frequency count is accurate to the nearest 10 Hz and when the analyzer is not phase locked the accuracy of the count is to the nearest 100 kHz. This sweep-stop mode can be switched off by the DOT INTENSITY control. Logic data, to stop the spectrum analyzer sweep and operate the counter, is transmitted through the interconnecting cable between the TRACK GEN LOGIC connectors and the data lines between the interface connectors of the TM 503 Option 7, or other compatible TM 500-Series mainframes.

In the non-sweep (Manual or External) the count is continuous. If the TR 502 is used with a 7L12 Spectrum Analyzer, or the frequency counter is not compatible with the operational logic of the TR 502, the analyzer should be operated in the non-sweep modes to measure frequency.

Connect and operate the system as follows:

1. Connect the AUX RF OUT through a  $50\ \Omega$  cable to the frequency counter Input. If the system has the Tracking Generator Logic feature, connect the logic interface cable to the TRACK GEN LOGIC connectors. Note: TM 500-Series mainframe must have the data lines between the interface connectors (Option 7 for TM 503).

2. Turn the power on.

3. With the 7L13 in the sweep mode, turn the DOT INTENSITY on and adjust the brightness level of the frequency dot.

4. Counter should now indicate the frequency of the dot.

#### NOTE

*The sweep stop trigger level of the TR 502 should be adjusted to match the 7L13 center screen level. Accuracy of the dot is not affected however. If a hole exists between the sweep stop point and the dot, it can be removed by referring to the Calibration section for adjustment procedure.*



# PERFORMANCE CHECK

## Introduction

This section contains two parts: An operational check-out procedure, for incoming inspection and instrument familiarization (this requires no test equipment) And a performance check procedure, that requires test equipment as the measurement standard to verify instrument specifications such as output level and flatness characteristics. The latter portion can be used to determine if the instrument needs repair or recalibration.

### 1. Preliminary Preparation

Connect the TR 502 to the 7L13 and/or 7L12 Spectrum Analyzer and perform the preliminary front panel set-up procedures and calibration described in the Operating Instructions.

### 2. Check Frequency Range

a. Set the spectrum analyzer Reference Level to 0 dBm by inserting rf attenuation. Set the vertical display to 10 dB/Div, the Span/Div to Max Span with the Resolution coupled (3 MHz) and switch the Phase Lock on. Set the TR 502 OUTPUT LEVEL to 0 dBm with the VAR dB control at 0. Connect the TR 502 RF OUT to the 7L13 or 7L12 RF Input by means of a short 50  $\Omega$  coaxial cable.

b. The display should be a horizontal line near full screen amplitude over the full 1800 MHz span across the screen.

### 3. Check RF OUT Amplitude Range

a. Set the spectrum analyzer Center Frequency to 500 MHz. Set the Freq Span/Div to 5 MHz with the Resolution coupled. Switch the Display Mode to 2 dB/Div and leave the Reference Level at 0 dBm.

b. Reduce the TR 502 OUTPUT LEVEL setting from 0 dBm to -9 dBm in 1 dB steps. Display level on the spectrum analyzer should drop by 4.5  $\pm$  1 division (9 dB  $\pm$  2.0 dB).

c. Rotate the VAR dB control through its full range. The display level on the spectrum analyzer should change about 1 division. Return the VAR dB control to its 0 dB position.

d. Reduce the OUTPUT LEVEL from 0 dBm to -50 dBm in 10 dB steps while changing the spectrum analyzer Reference Level from 0 dBm to -50 dBm. The display level should return to the original reference level (within  $\pm$  1.0 division) after each step.

### 4. Check Flatness

a. Set the spectrum analyzer Freq Span Div to Max Span with the Resolution control coupled (3 MHz). Leave the vertical display at 2 dB/Div and the Reference Level at 0 dBm.

b. Set the TR 502 OUTPUT LEVEL to -10 dBm.

c. Observe the display flatness. Display should be flat (within  $\pm$  1 division or  $\pm$  2 dB) over the 100 kHz to 1.8 GHz span (see Fig. 3-1). Disregard the spectrum analyzer 0 Hz response at the left edge of the display.

## PERFORMANCE CHECKS WHICH REQUIRE TEST EQUIPMENT

### Introduction

The following procedures check the amplitude range and accuracy, TR 502 output flatness, residual FM, auxiliary output level, and output level of spurious signals.

### Equipment Required

a. Power Meter: Measurement range up to 0 dBm. General Microwave Model 454A or Hewlett Packard Model 435A with 8482A Power Sensor.

b. Test Spectrum Analyzer: Tektronix 7L13 or 7L12

c. Mainframe for Spectrum Analyzer: Tektronix 7000-Series with storage; such as 7613.

### 1. Check Amplitude Range and Output Flatness

a. Set the spectrum analyzer Center Frequency to 50 MHz and decrease the Freq Span/Div to 0 Hz so the frequency is not swept. Switch the Phase Lock on.

## Performance Check—TR 502

b. Connect the TR 502 RF OUT to the power meter with a short length of 50  $\Omega$  coaxial cable. Set the VAR dB control to 0 dB and the OUTPUT LEVEL dBm selector to 0. The power meter should indicate 0 dBm  $\pm$ 0.5 dB.

c. Reduce the OUTPUT LEVEL dBm in 1 dB steps then 10 dB steps and check that the power meter reading indicates the OUTPUT LEVEL, within 0.2 dB/dB step to a maximum of  $\pm$ 2.0 dB for the total 9 dB or 50 dB range.

d. Return the OUTPUT LEVEL dBm to 0 and check the OUTPUT LEVEL at various frequency points throughout the 1.8 GHz range.

e. Power meter should indicate 0 dBm  $\pm$ 0.5 dB for all frequency points checked.

### 2. Check Auxiliary Output Power

a. Leave the spectrum analyzer controls as previously set in step 1. Connect the power meter to the TR 502 AUX RF OUT. Set the OUTPUT LEVEL dBm control to -10 dBm to terminate the RF OUT connector.

b. Tune the spectrum analyzer frequency over the 100 kHz to 1.8 GHz range and check that the AUX RF OUT power is at least -7 dBm (0.1 V rms into 50  $\Omega$ ) as indicated on the power meter over the frequency range.

#### NOTE

*This specification is the minimum output level. Output varies with VAR dB control setting. Instrument should put out -7 dBm even with VAR dB in the low-power position.*

### 3. Check Residual FM (peak to peak)

a. Tune the spectrum analyzer frequency to 50 MHz. Leave the Freq Span/Div at 0 Hz.

b. Connect the TR 502 RF OUT to the input of a test 7L13 or 7L12 Spectrum Analyzer. Set the test spectrum analyzer Reference Level at 0 dBm, the Freq Span/Div at 200 Hz with the Resolution at 30 Hz. Adjust the TR 502 output frequency with the spectrum analyzer so its output is centered on the test spectrum analyzer display. Check the display for residual fm. Residual fm should not exceed 100 Hz with the 7L13 or 200 Hz with the 7L12.

#### NOTE

*Use a Freq Span/Div of 500 Hz with a Resolution of 300 Hz when checking a 7L12/TR 502 System.*

### 4. Check For Spurious Signals

a. Leave the TR 502/Spectrum Analyzer system controls as previously set in step 3 and set the test spectrum analyzer controls as follows: Freq Span/Div to 20 MHz with the Resolution coupled, Center Frequency 100 MHz, and Display Mode of 10 dB/Div.

b. Check the harmonic related spuri (at 100 MHz, 150 MHz, and 200 MHz) are at least 20 dB down from the tracking generator output level at 50 MHz.

c. Tune the test spectrum analyzer frequency up to 1800 MHz checking that all non-harmonic (not multiples of 50 MHz) spuri are at least 40 dB down from the reference level at 50 MHz.

d. Tune the TR 502/Spectrum Analyzer system to other reference frequencies within the frequency range and check to ensure non-harmonic spuri are at least 20 dB down from the reference.

This concludes the performance verification check for the TR 502/Spectrum Analyzer system.

# CALIBRATION PROCEDURE

This section provides adjustment procedures and internal checks for the TR 502. After calibration, perform the Performance Check in Section 3 to verify instrument performance. The limits, tolerances and waveform illustrations in this procedure are aids to calibrate the instrument and are not intended as circuit specifications.

## Complete or Partial Calibration

The procedure is written in a logical sequence. If the instrument is known to be completely out of calibration, the sequence should be followed. The circuits, including the microwave integrated circuits, for this instrument are very stable. Complete calibration or recalibration may therefore be necessary only after a component has been replaced or the instrument fails to meet performance requirements. The Performance Check has been written to lead you to the proper adjustment or circuit. We advise recalibrating only those circuits that do not meet specifications. Turn to the desired step and prepare the instrument for calibration by referring to the preceding setup and controls settings then adjust or calibrate as directed.

The 2.2 GHz four-cavity filter and mixer adjustments are only required if the filter or mixer assembly is replaced. The adjustment procedure for this filter is part of the replacement instructions in the Maintenance Instructions (Section 6) of the manual.

The instrument should be cleaned and inspected, as described in the Maintenance section, before performing a complete calibration.

## Adjustment and Test Locations

Test point and adjustment locations are shown with or adjacent to the written procedure. These points and adjustments are accessible with the outer covers removed.

## History Information

The instrument and manual are periodically evaluated and updated. If modifications require changes to the calibration procedure, history information applicable to earlier instruments is integrated into or written as a subpart of the step.

## Interaction

Adjustments that interact with other circuits are noted and reference made to the affected circuit.

## Equipment Required

The equipment that is required to recalibrate this instrument includes the equipment listed for the Performance Check plus the following:

DC Voltmeter or Multimeter:	0 to 50 V range; Tektronix DM 501 of the TM 500-Series or a Triplet Model 630-PL.
Frequency Counter:	Frequency range to 60 MHz, short term stability 1 part in $10^7$ ; resolution 200 Hz @ 52.5 MHz, Tektronix 7D14 for the 7000-Series or a DC 501, DC 502, of TM 500-Series.
Vertical Amplifier Plug-In Unit:	Sensitivity 5 mV to 5 V. Bandwidth 50 MHz or better.
1X Probe (100 MHz):	Tektronix P6062A.
10X Probe (100 MHz):	Tektronix P6062A.
Plug-In Extender for TM 500:	Tektronix Part No. 067-0645-01.

## Preliminary Preparation

### NOTE

*Instrument calibration should be performed with the ambient temperature equal to the normal operating temperature, after a warmup period, with power on, equal to the warmup requirements for the 7L13 or 7L12 to stabilize.*

a. Check the front panel controls for smooth operation and proper indexing.

b. Turn the power to the TR 502 off. Remove the TR 502 from the TM 500 mainframe and connect it through a flexible plug-in extender to the mainframe interface connector. Fig. 4-1 illustrates typical setup for calibration. Turn the power on.

c. If adjustment of the 52.5 MHz Mode Adjust is required, remove the cover plate to the honeycomb assembly to gain access to the mode adjustment.

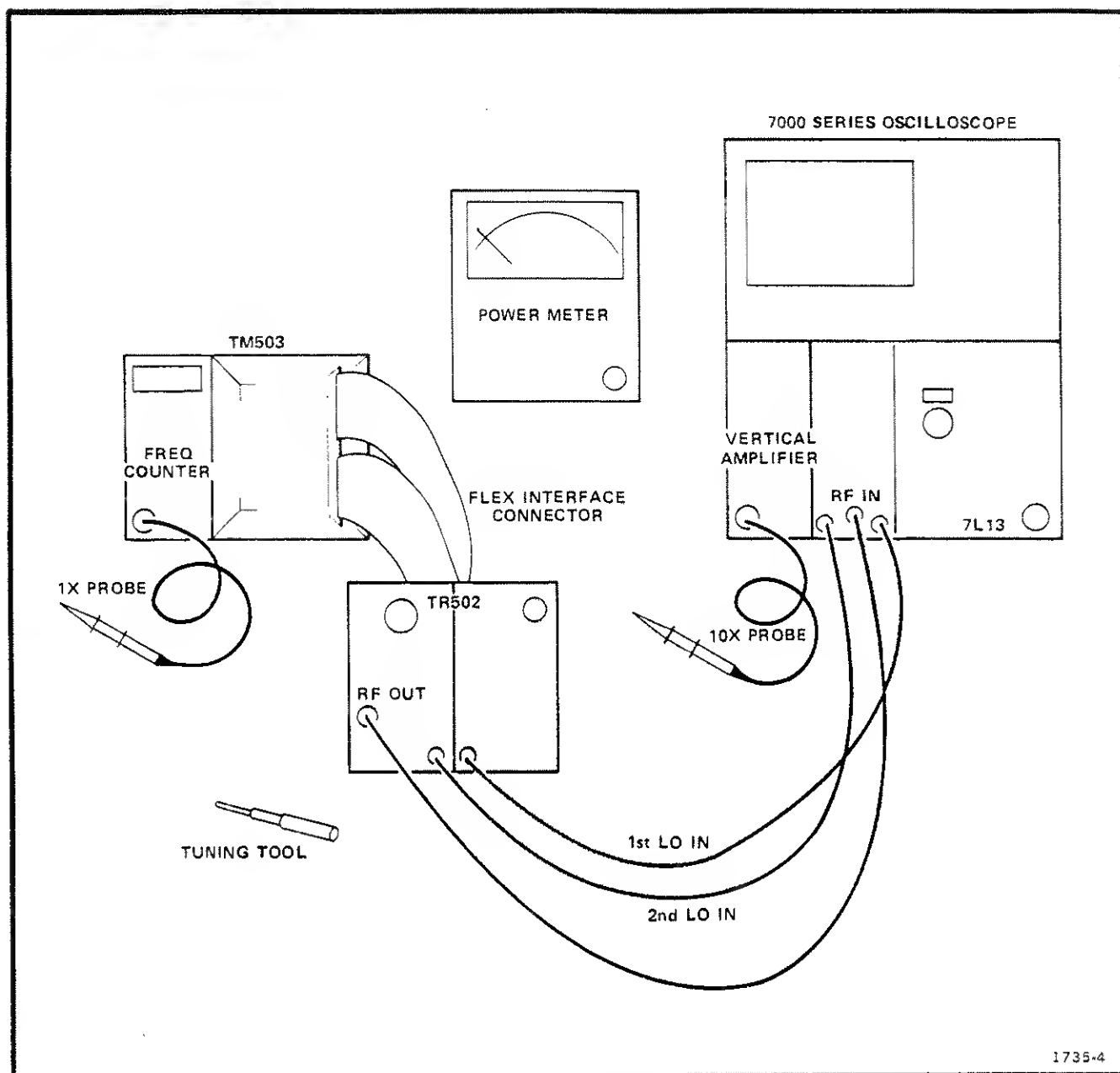


Fig. 4-1. Setup for Calibration.

**NOTE**

*This adjustment is required only when tracking accuracy is out of specifications or a frequency-determining component, such as the crystal or the IC (U520), has been replaced.*

**NOTE**

*Use a low-capacitance probe to minimize loading and connect the ground lead of the probe to the TR 502 chassis. Output of U520B is approximately 800 mV peak to peak.*

**1. 52.5 MHz Oscillator Mode Adjust**

a. Connect a frequency counter, through a 1X probe, to receptacle K or W520; and the Input to a vertical amplifier, through a 10X probe, to receptacle K or W250 (Fig 4-2).

b. Adjust the Mode Adjust C524 (Fig. 4-2) so the 52.5 MHz oscillator starts at any position of the TRACKING ADJUST control as the power is turned off and on. (Power should be off long enough for the supply voltage to decay before switching back on.)

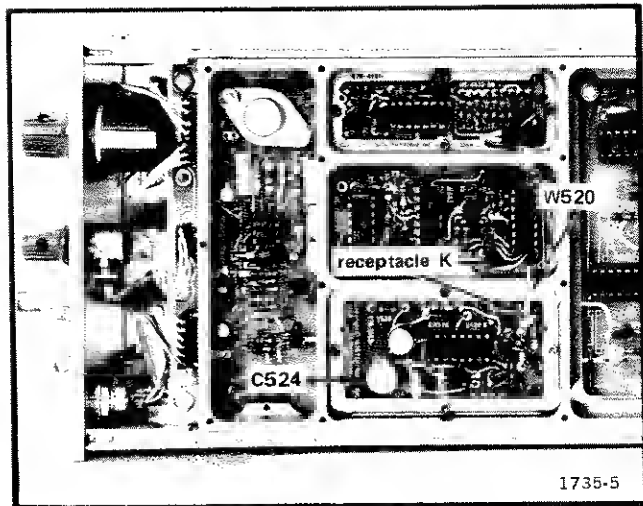


Fig. 4-2. Location of receptacle K, W520, and C524.

c. Check the frequency range of the TRACKING ADJUST and if necessary, adjust C524 (Mode Adjust) so the range is at least  $\pm 1.0$  kHz either side of 52.5 MHz.

d. Replace the honeycomb cover then check the TRACKING ADJUST range to ensure that the tracking accuracy is such that it tracks the 7L13 or 7L12 input frequency at the lowest resolution bandwidth settings (30 Hz for 7L13, 300 Hz for 7L12).

## 2. Adjust the Normalizing Attenuator

### NOTE

*The range of this adjustment is broad. It should only require adjustment when the 2.095 GHz oscillator and Amplitude Control assembly is replaced or the flatness is out of specification.*

a. Set the spectrum analyzer Frequency Span/Div to Max and Time/Div to 10 ms.

b. Adjust the Signal Level Normalization with R215 for 1.5 V drop across R210 (Fig. 4-3).

## 3. Output Level Calibration

a. Apply the 50 MHz Calibrator signal to the spectrum analyzer Input and tune the center frequency to 50 MHz. Reduce the Frequency Span/Div to 0 keeping the input tuned to 50 MHz.

b. Remove the Calibrator signal to the analyzer and connect a power meter (such as HP Model 435A) to the TR 502 RF OUT.

c. Set the VAR dB control to  $-2$  and adjust the Min Output Level with R225 (Fig. 4-3) for  $-2$  dBm output level.

d. Set the VAR dB control to 0 and adjust the Max Output Level with R220 (Fig. 4-3) for 0 dBm.

e. Set the VAR dB control to  $-1$  and adjust the VAR dB Linearity with R222 (Fig. 4-3) for  $-1$  dBm.

f. Recheck the 0 and  $-1$  positions because of interaction.

g. Check the output level calibration at  $-0.5$  and  $-1.5$  settings of the VAR dB control.

## 4. Sweep Trigger Level Adjustment

The Sweep Trigger Level is adjusted to match the TR 502 sweep stop trigger level to the 7L13 center screen level.

a. With the TR 502/7L13 and compatible frequency counter (DC 502 with Option 7) connected as a system and the TR 502 out of the TM 500 Power Module compartment, on an extender cable, calibrate the 7L13 span so the center of the display is accurate (see 7L13 Operating Instructions).

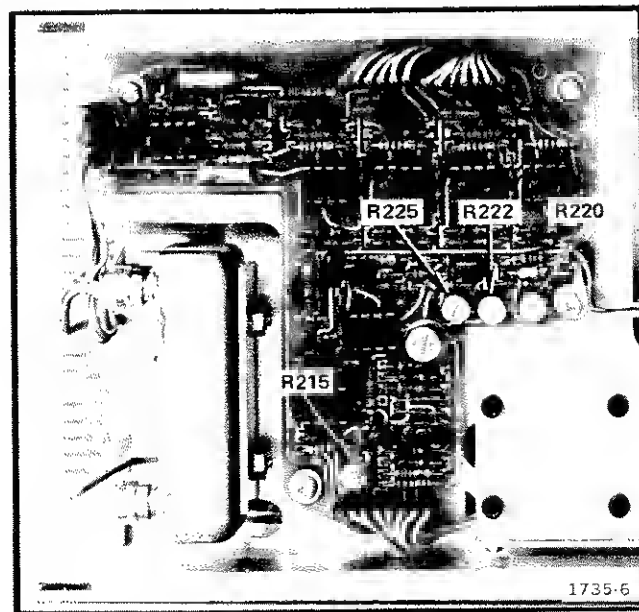


Fig. 4-3. Location of Signal Level Normalization Adjustment R215, and Output Level Calibration Adjustments R225, R220, R222.

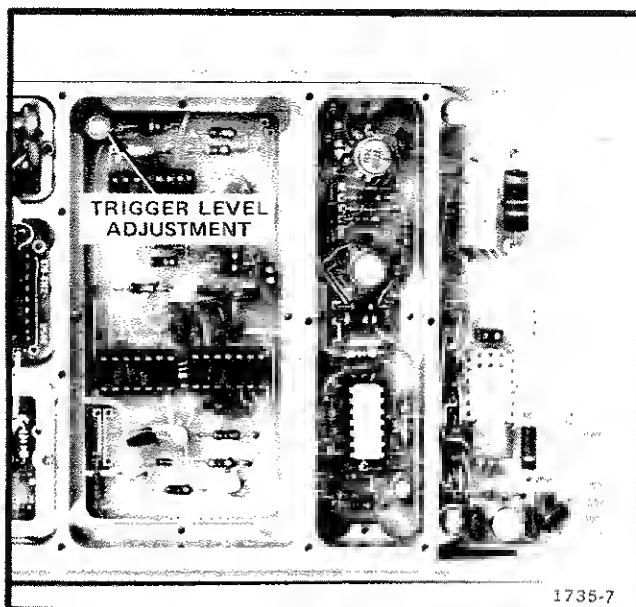


Fig. 4-4. Location of Trigger Level Adjustment.

b. Set the 7L13 Frequency Span/Div to Max and turn the TR 502 DOT INTENSITY control clockwise until the dot is visible on the analyzer display.

c. Adjust the Sweep Trigger Level R475 (Fig. 4-4) until the sweep stop point is next to the dot (Fig. 4-5).

This completes the calibration procedure for the TR 502. Verify its operation by the Performance Check in Section 3.

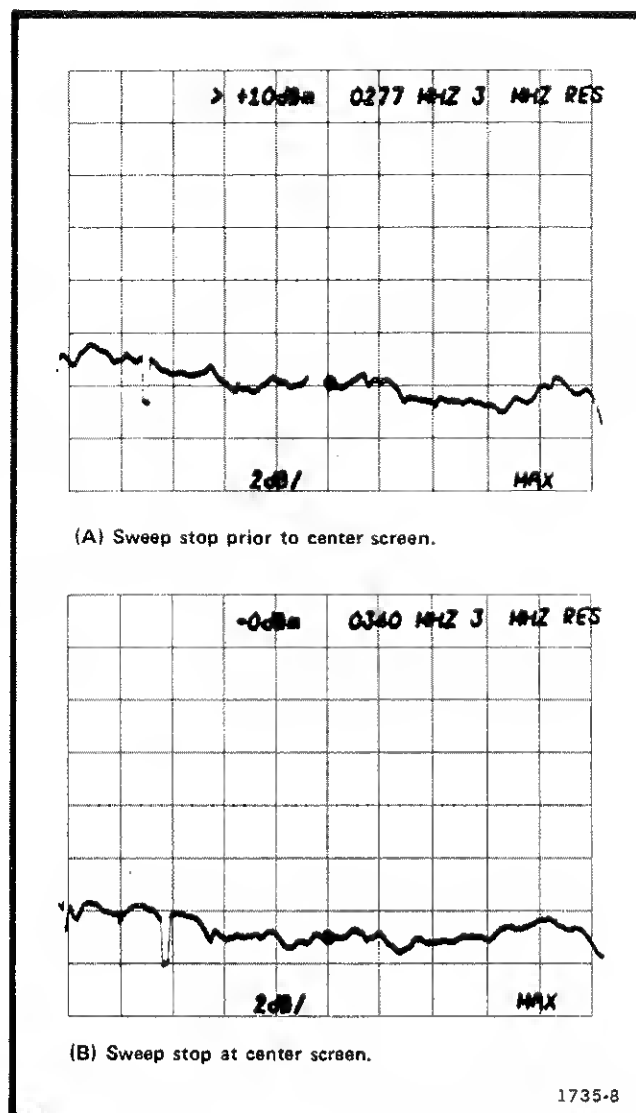


Fig. 4-5. How the sweep stop should align to the dot position.



# CIRCUIT DESCRIPTION

This section describes the functions of the major circuits and their relationship to each other. The description is general and is intended as an aid for the technician and operator to facilitate servicing the instrument or operating it to its fullest capabilities. The section starts with a block diagram description, followed with a more detailed analysis of the major circuits. The diagrams may contain typical waveforms, voltage data, and signal levels for full screen display, to help understand circuit functions and aid in troubleshooting.

## BLOCK DIAGRAM DESCRIPTION

The spectrum analyzer (7L13 or 7L12) up-converts its input signal frequency to a 1st IF of 2.095 GHz, by the 1st LO (local oscillator) frequency, then down-converts this 2.095 GHz by the 2nd LO frequency to obtain an IF of 105 MHz. The TR 502 Tracking Generator reverses this sequence to generate an output signal with a frequency equal to the input frequency to the spectrum analyzer. For example: an input signal frequency of 900 MHz to the spectrum analyzer is up-converted to 2.095 GHz by the mixing action with the 1st LO frequency of 2.995 GHz. This signal is then converted down to 105 MHz by heterodyning the 2.095 GHz with the 2nd LO signal frequency of 2.2 GHz. The TR 502 Tracking Generator converts a 105 MHz reference signal to 2.095 GHz by using the 2nd LO signal (2.2 GHz) in a phase-lock loop. This 2.095 GHz is then mixed with the 1st LO signal of 2.995 GHz to generate an output of 900 MHz.

The tracking generator 2.095 GHz oscillator is phase-locked 105 MHz below the spectrum analyzer 2nd LO frequency. This difference frequency, from the mixer, is maintained at 105 MHz by dividing it down to 52.5 MHz and comparing this to a 52.5 MHz crystal-controlled oscillator. A voltage that is proportional to the phase difference is fed back as an error signal to keep the 2.095 GHz voltage-controlled oscillator offset 105 MHz below the 2nd LO input signal.

The 2.095 GHz signal is passed through a directional coupler which couples some of the signal to the phase-lock loop and directs the remaining energy through a normalizing attenuator (which establish amplitude level) a 2.2 GHz low-pass filter (to attenuate harmonics and upper sidebands from the output mixer), a second leveling attenuator, an isolation amplifier, and a 6 dB attenuator into the output mixer. The isolation amplifier prevents energy, from the output mixer, feeding back into the

2.095 GHz oscillator and the phase-lock mixer circuit. At zero frequency the 1st LO is near 2.095 GHz which, if allowed to feed back to the 2.095 GHz oscillator, would disable the phase-lock operation. The 6 dB attenuator provides the proper impedance termination into the output mixer to reduce the effects of output impedance characteristics of the isolation amplifier.

The conversion loss through the output mixer is constant with frequency. The amplitude level of the IF signal tracks the amplitude of the rf signal with about 6 dB to 8 dB of loss. The IF level is therefore set by controlling the rf input level. A constant output level is maintained by means of a feedback loop that controls the attenuation in the 2.095 GHz signal path. The forward signal path through the attenuator affects the signal level at the level detector. The feedback path applies this level to the leveling attenuator as a correction signal so the output remains constant over the frequency range of the instrument.

The input signal from the 1st LO is 3 mW or more. This is amplified by the 2.1 GHz to 3.9 GHz amplifier so the level into the LO port of the output mixer is between 5 mW to 10 mW. Harmonics of the input signal frequencies are attenuated by the 2.1 GHz to 3.9 GHz bandpass filter. Re-entrant modes of the bandpass filter are eliminated by a low-pass filter. Good termination for the amplifier and bandpass filter is provided by the two isolators. Isolation between the output mixer and the 1st LO is provided by the two isolators and the amplifier. This isolation and the filter prevent signals in the 0 to 1.8 GHz and 4.2 GHz to 6 GHz range from getting back into the spectrum analyzer. These signals, if allowed to feed back to the spectrum analyzer, would degrade the analyzer sensitivity and cause the baseline of the display to lift.

The operational logic interfaces the TR 502 to the spectrum analyzer and an external digital counter. This logic controls the sweep function of the spectrum analyzer and the frequency counting function of the frequency counter for the various modes of operation.

## DETAILED DESCRIPTION

### RF and Microwave Circuits

The RF section consists of microwave assemblies that include microwave integrated circuits in metal enclosures. Because repair of these assemblies requires special techniques and equipment we recommend replacing the

entire assembly if it should fail. The diagrams for these assemblies show only the basic configuration and illustrate their function and dc paths between the external connectors.

The input signal from the spectrum analyzer 1st LO is amplified to a level of about 10 mW by the 2.1 GHz to 3.9 GHz amplifier. Gain of the amplifier is nominally 6 dB. Because of gain characteristics, this amplifier operates as a limiter and provides a relatively constant output over a wide range of input signal levels. This limiting action provides a constant LO signal level to the output mixer when the TR 502 is interfaced with different spectrum analyzers.

The 2 to 4 GHz isolators have less than 0.4 dB loss in the forward direction and more than 20 dB loss in the reverse direction. The 4.5 GHz low-pass filter is a tubular type filter used to attenuate the re-entrant mode of the interdigital bandpass filter (third multiple of its pass-band). This bandpass filter attenuates harmonics of 2.1 GHz to 3.9 GHz signals that are generated by the spectrum analyzer and the saturated 2.1 GHz to 3.9 GHz amplifier. This filter also attenuates any 0 to 1.8 GHz and 4.2 GHz to 6 GHz signals that return from the output mixer of the TR 502.

The mixer requires about 5 mW into the LO port and a nominal -24 dBm into the rf port. The IF output of the mixer is about -30 dBm over the frequency range of 0 to 1.8 GHz.

The 2nd LO signal from the spectrum analyzer is applied through a 20 dB attenuator, a 2.2 GHz low-pass filter, and a four-cavity bandpass filter to the mixer. The 2.2 GHz low-pass filter attenuates or blocks the re-entrant modes (6.6 GHz and 11.0 GHz) of the multi-cavity bandpass filter. The pass-band of the filter is narrow enough to attenuate the 2.095 GHz oscillator signal and prevent this signal from getting back into the spectrum analyzer. Adjustment of the bandpass filter response is accomplished by the four tuning screws, one for each cavity. The signal then passes to a two-diode balanced mixer where it is mixed with the 2.095 GHz oscillator signal. The mixer is adjusted for balance and coupling.

The 105 MHz IF signal from the mixer is passed through a directional coupler and an all-pass network to the 105 MHz amplifier. The all-pass network terminates the high frequency energy that comes through the directional coupler.

The 2.095 GHz oscillator uses a resonant micro-strip line in the collector of a common-base transistor oscillator to establish its frequency. It is tuned (about 20 MHz) by varying the collector voltage to change the collector-to-base capacitance.

The 2.095 GHz signal is fed from the directional coupler to a PIN diode attenuator with the diode operating as a variable resistor. The circuit is basically a T-type attenuator with the resistance of the diode the inverse of the current. As the current increases the diode resistance varies from open circuit to about 5  $\Omega$  (current increase from 0 to about 5 mA). This variable allows for the initial adjustment of the output level range.

The 2.2 GHz low-pass filter attenuates harmonics of the 2.095 GHz frequency in the forward direction, and higher frequencies (i.e., 2.2 GHz and higher) that get through the isolation amplifier from the output mixer.

The leveling attenuator is identical to the normalizing attenuator. The isolation amplifier gain is about 7 dB with greater than 20 dB of reverse isolation. Its output drives the mixer through a 6 dB attenuator.

The lower conversion frequencies from the mixer pass through a 3 dB attenuator and low-pass filter to the wideband amplifier. The 3 dB attenuator provides a wideband (to 6.6 GHz) termination for the mixer. The low-pass filter attenuates 2.095 GHz and its upper sideband frequency components (that come out of the mixer) from reaching the wideband amplifier.

The low-pass filter is flat to 1.8 GHz and rolls off with a sharp notch at 2.095 GHz. The 0 to 1.8 GHz signal is then amplified about 40 dB by the wideband amplifier, then passed through another 1.8 GHz low-pass filter to the power divider and level detector.

The second 1.8 GHz low-pass filter attenuates frequencies above 1.8 GHz which may be generated by the amplifier. Harmonic distortion increases as the signal frequency or level increases.

The level detector is a directional peak detector that senses the forward power but not the reflected or reverse power. Forward power is independent of the load. Power loss through the divider to the RF OUT connector is about 6 dB and 9.5 dB to the AUX RF OUT connector. Power at the AUX RF OUT port is therefore about 3.5 dB below the power at the RF OUT port. The output attenuator provides calibrated 1 dB and 10 dB steps of output power to the RF OUT connector.

### **Bias and Leveling Loop Circuitry**

Bias for the amplifiers, in the microwave assembly and the isolation amplifier, is supplied by five bias supplies (U150, U160, U170, U180, and U240) on the Bias circuit board. The bias circuits and amplifier are connected as a feedback loop with the collector load current of the

amplifier sensed as a voltage by the input resistor (R) to the operational amplifier. This voltage is compared to a  $-10$  V reference. The amplifier output drives the base of the rf amplifier to set the bias. The collector voltage is therefore held constant at  $-10$  V. The load resistors for the output amplifiers are R140, R162, R174, and the resistor in the microwave assembly for the last amplifier stage. These resistors set the collector currents of the first two amplifiers at about 10 mA, the third at 20 mA, and the last at 30 mA. The load resistor for the isolation amplifier is R242. Collector current is about 15 mA.

The  $-10$  V reference for the bias circuits is generated by a voltage regulator circuit using an operational amplifier U250. The reference for the regulator is a 6.2 V Zener diode VR258, which sets the voltage level at the inverting input of the amplifier. The amplifier boosts this voltage to  $-10$  V. The  $-10$  V supply provides the bias current for the 6.2 V Zener. A 7.5 V Zener (VR250) is connected from the output to the  $-15$  V supply to start the regulator. As soon as the output of the regulator exceeds 7.5 V the Zener diode no longer draws current and does not affect regulator operation.

Diode CR250, between the  $-15$  V line and ground, protects the microwave circuitry from any unintentional application of negative voltage on the line.

The leveling loop consists of a level detector and temperature-compensating diode driving a differential amplifier. The output of the amplifier drives another amplifier which sets the attenuation of the leveling attenuator. The diodes are biased so their output is approximately  $-0.4$  V with no power into the detector. The output of the diodes drive the inputs of a differential amplifier U200. The output of the compensation diode is summed with a voltage set by the leveling control circuit. The temperature-compensating diode compensates detector output changes due to temperature. As the power into the detector increases, the output is an average signal, that is below  $-0.4$  V with the positive excursions of the signal clamped at  $-0.4$  V.

U200 is an operational amplifier configured as an integrator. Its output is a correction signal which ranges either in a positive or negative direction depending on the difference between the level detector voltage and a reference voltage. This reference voltage depends on the output of a voltage divider network, consisting of adjustments R225, R220, R222, and the front panel VAR dB control. Min Output Level adjustment R225, sets the offset constant or minimum level. Max Output Level adjustment R220, sets the range of the VAR dB control to about 2 dB. The VAR dB Linearity adjustment R222, shapes the response of the output level versus the rotation of the control so the dial is calibrated in dB. A 6.2 V Zener diode (CR262) sets the reference for the output level control circuitry.

## Phase Lock Loop

The 2.095 GHz oscillator in the TR 502 is phase locked 105 MHz below the 2.2 GHz signal from the spectrum analyzer. The difference signal (105 MHz) from the mixer is amplified through four amplifier stages, then divided down to 52.5 MHz and compared with 52.5 MHz crystal-controlled oscillator signal. A voltage that is proportional to the phase difference is fed back to correct the phase of the 2.095 GHz oscillator so that its resultant output is locked 105 MHz below the 2nd LO of the spectrum analyzer.

U500 and U540 are differential amplifiers with emitter follower outputs. The differential output of U500A drives the differential input of U500B and the output of U540B drives the differential input to U540A. Gain of each stage is about 15 dB. The output level of the amplifier stages remains relatively constant over an input level range from  $-45$  dBm to  $-10$  dBm. This output is applied to a divide-by-two counter (U550) and the resultant 52.5 MHz is applied to the phase/frequency detector U545 for comparison to the 52.5 MHz crystal-controlled oscillator signal.

The reference 52.5 MHz signal from the crystal-controlled oscillator U520A is applied through a buffer stage (U520B) to the other input of the phase/frequency detector. The crystal operates in its third overtone which is selected by the low Q resonant circuit tuned by C524. The frequency can be tuned through 52.5 MHz by C530 and the voltage that is applied to the variable capacitance diode CR526. Bias to the diode is varied by the front panel TRACKING ADJUST control R10. (Voltages for the adjustment are supplied by U365B.) This control allows the operator to set the TR 502 output frequency at the spectrum analyzer input frequency or offset the frequency a slight amount.

The output of the detector is applied to a compensating amplifier U365A, Q420. The compensating amplifier has a buffered output that drives the collector of the 2.095 GHz transistor oscillator. Q440 limits the output current if the output should inadvertently be shorted.

Transistors Q445 and Q430 are the active components for a anti-latch circuit. This circuit, when activated, drives the compensating amplifier so its output tune voltage causes the 2.095 GHz oscillator to search through a frequency band until it locks to the 2.2 GHz 2nd LO frequency, of the spectrum analyzer. When the tune voltage drops to  $-3$  V or less, Q445 is cut off. The collector voltage rises towards  $V_{cc}$  and allows C432 to charge through R438 and R444 until it reaches 0.7 V above the gate potential of the programmable unijunction transistor Q430. When the programmable unijunction transistor turns on, the charge on the capacitor C432 is transferred to the cathode and through CR432 to the non-inverting

input of the operational amplifier and capacitor C428. The output of the compensating amplifier steps positive to about  $-18$  V then decays at a linear rate towards 0 V. As it passes through the voltage required to generate an oscillator frequency, that will lock to the 2nd LO of the spectrum analyzer, the phase lock circuit regains control. If the oscillator fails to start or lock, the cycle repeats.

Q410 is the 25 mA current source for the 2.095 GHz oscillator. Q480 is the output of the  $-20$  V supply for the compensation amplifier circuitry.

### Operational Logic

This circuit provides the logic required to control an external digital counter plug-in unit (such as the DC 502 Option 7) and the 7L13 Spectrum Analyzer for various counting modes. If the analyzer is operating in a sweep mode, the counter will count the center frequency as the sweep passes center. When the analyzer is operated in manual, external sweep, or a non-sweep mode, the counter will count continuously.

In the sweep mode, the sweep is stopped at center screen, centered, and held at center long enough for the counter to make a count, then allowed to continue to the end of the sweep. The circuit can be switched off by the DQT INTENSITY control.

A negative-going sweep voltage from the analyzer is applied to the input of the comparator U470. When the sweep crosses the level set by the Sweep Trigger Level adjust R475 the output of U470 steps high. This triggers the mono-stable multivibrator U455B and its output goes low. This low is gated through U460C and U460B to stop the sweep. After the centering hold-off interval, set by C456 and R456, the output of U455B returns to its high state. This triggers U455A and its output produces a short positive pulse. A high on this line tells the counter to start its count. The centering hold-off interval assumes that this start count signal does not go out to the counter until the sweep has had time to center. When the count starts, a negative gate is fed from the counter through U460C to U460B for the duration of the count. This holds the sweep while the count is made. When the count is finished the gate output steps high and the sweep is allowed to resume.

The phase lock logic line tells the counter how accurate to count. In the phase lock mode, the count is to the nearest 10 Hz and with phase lock off to the nearest 100 kHz.

The non-sweep logic line tells the counter if the analyzer is in the sweep or non-sweep mode. If the spectrum analyzer scan operation is manual, external sweep, or off, this line goes low. If the line is high the analyzer is in a sweep mode and sweep stop counting is enabled.

Grounding pin B14 tells the counter that it should slave to the tracking generator. Pin B17 is pulled low when a counter is connected to the system. This enables the sweep stop mode when the counter switch is closed and the non-sweep line is high.

The counter switch on the DQT INTENSITY control disables the stop sweep mode when it is open (control fully ccw). Turning the DOT INTENSITY towards the positive end increases the Z axis blanking during sweep stop. Q450 supplies positive current through CR466 to the Z axis blanking. During sweep mode, Q455 is turned on to divert the current and prevent blanking.

### Power Supply Regulators

Three power supply regulators (U350, U370, and U390) provide regulated  $-15$  V,  $-15$  V, and  $-5$  V, for instrument power. These IC regulators use external pass transistors that are located in the TM 500 mainframe (positive supplies) and on the Mother board of the TR 502 ( $-15$  V supply). All are short-circuit limited with foldback current limiting. For example: the  $-15$  V supply (U390) current sensing resistor is R394, the foldback circuit includes R398, R396. If current delivered to the load becomes excessive, the voltage drop across R394 will be enough to turn the current-limiting transistor Q395 on. This decreases the current through the pass transistor Q390 and limits the current to the load. Foldback current is approximately 50 mA ( $1$  V/ $20$   $\Omega$ ). Power dissipation in the pass transistor is about 1 watt ( $50$  mA  $\times$   $20$  V). If the  $-15$  V line is shorted to ground, the current is limited to about 35 mA ( $0.7$  V/ $20$   $\Omega$ ). Power dissipation is now about 1.2 watts ( $35$  mA  $\times$   $35$  V).

# MAINTENANCE INSTRUCTIONS

## Introduction

Maintenance for the TR 502 consists of preventive steps to reduce the possibility of instrument failure and the corrective measures to take if trouble or a malfunction should occur.

## PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, performance check, and if needed, a recalibration. The preventive maintenance schedule that is established for the instrument should be based on the environment in which the instrument is operated and the amount of use. Under average conditions (laboratory situation) a preventive maintenance check should be performed every 1000 hours of instrument operation.

### Cleaning

Clean the instrument often enough to prevent dust or dirt from accumulating in or on it. Dirt acts as a thermal insulating blanket to prevent efficient heat dissipation and in a humid environment high resistance electrical leakage paths are provided between conductors or components.

**Exterior.** Clean the dust from the outside of the instrument by wiping or brushing the surface with a soft cloth or small brush. The brush will remove dust from around the front panel selector buttons. Hardened dirt may be removed with a cloth dampened with a mild detergent solution. Abrasive cleaners should not be used.

**Interior.** Normally the interior of the instrument will not require cleaning unless it has been left out of the mainframe plug-in compartment and uncovered for an extended period of time. Clean the interior by loosening accumulated dust with a dry soft brush, then remove the loosened dirt with low pressure air to blow the dust clear. (High velocity air can damage some components.) Hardened dirt or grease may be removed with a cotton tipped applicator dampened with a solution of mild detergent in water. Abrasive cleaners should not be used. If the circuit board assemblies need cleaning, remove the circuit board and wash with mild detergent solution, then rinse and dry.

After cleaning, allow the interior to thoroughly dry before applying power to the instrument.

### CAUTION

*Do not allow water to get inside any enclosed assembly or components such as the hybrid assemblies, RF attenuator assembly, potentiometers, etc. Do not clean any plastic materials with organic cleaning solvents such as benzene, toluene, xylene, acetone or similar compounds because they may damage the plastic.*

### Lubrication

No components in this instrument require lubrication.

### Visual Inspection

After cleaning, carefully check the instrument for such defects as defective connections, damaged parts, and improperly seated transistors and integrated circuits. The remedy for most visible defects is obvious; however, if heat-damaged parts are discovered, try to determine the cause of overheating before the damaged part is replaced, otherwise the damage may be repeated.

### Transistor and Integrated Circuit Checks

Periodic checks of the transistors and integrated circuits are not recommended. The best measure of performance is the actual operation of the component in the circuit. Performance of these components is thoroughly checked during the performance check or recalibration. Any substandard transistors or integrated circuits will usually be detected at that time. More details on checking semiconductor operation are given under troubleshooting.

### Performance Checks and Recalibration Schedule

The instrument performance should be checked after each 1000 hours of operation or every six months, whichever occurs first, to ensure maximum performance. A performance check will also assist in locating defects that may not be apparent during regular operation. Instructions for conducting a performance check are provided in the Performance Check section of this manual. Recalibration should only be done if the instrument does not meet performance specifications.

## TROUBLESHOOTING

The following are a few aids and suggestions that may assist in locating a problem. After the defective assembly or component has been located, refer to the Corrective Maintenance part of this section for removal and replacement instructions.

### Troubleshooting Aids

**Diagrams.** Circuit diagrams are on foldout pages in the Diagrams section of the manual. The circuit number and electrical value of each component is shown on the diagrams (see the first tab page for definition of the reference symbology used to identify components in each circuit). Each major assembly is assigned a block of component numbers. Refer to the Electrical Part List section for a complete description of each component and assembly. Those portions of the circuit that are mounted on circuit boards are enclosed with a gray border with the name and assembly number shown on the border.

Nominal voltages and signal levels required to give full screen deflection are included on the diagrams.

Exploded drawing of the instrument is provided after the Mechanical Parts List.

### NOTE

*Corrections and modifications to the manual and instrument are described on inserts bound into the rear of the manual. Check this section (change information) for changes and corrections to the manual or instrument.*

**Circuit Board Illustrations.** Electrical components, connectors and test points are identified on circuit board illustrations located on the inside fold of the corresponding circuit diagram or the back of the preceding diagram.

**Wiring Color Code.** Color-coded wires are used to aid circuit tracing. Power supply dc voltage leads have either a white background, for positive voltage, or a violet background for negative voltage. Signal wires and coaxial cables use an identifying one-band or two-band color code.

### Connectors (Movable and Fixed).

**Multiple Terminal (Harmonica) Connector Holders.** The multi-connector holder is keyed with a triangle symbol, one on the holder and one on the circuit board surface. The orientation of the triangle and the slot

numbers on the connector holder are determined by the direction of the nomenclature marking (see Fig. 6-1). All harmonica connectors are identified on the schematic and board with the prefix "P".

**Square-pin and Edge Connectors:** Interface connectors between the circuit board and the mainframe use an alpha prefix for the left (A) and right (B) side followed by a numeral (e.g., B17, A6).

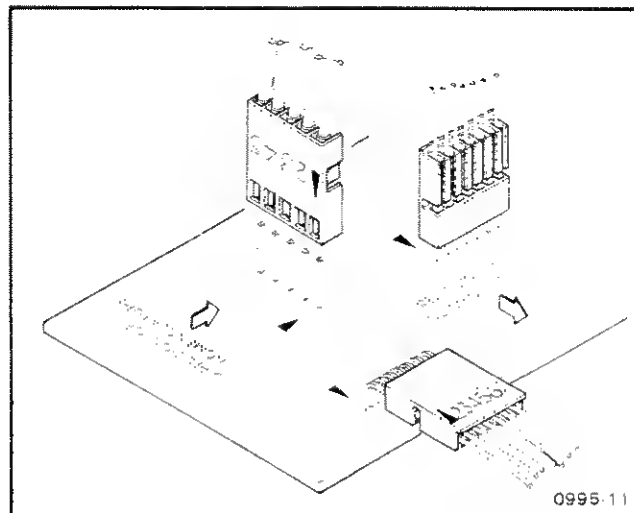


Fig. 6-1. Multipin (harmonica) circuit board connectors.

**Capacitor Marking.** The capacitance value of common disc capacitors and some electrolytics are marked in microfarads on the side of the component body. The white ceramic capacitors are color coded in picofarads. Tantalum capacitors are color coded as shown in Fig. 6-2.

**Diode Code.** The cathode of each glass encased diode is indicated by a stripe, a series of stripes, or a dot. Some diodes have a diode symbol printed on one side. Fig. 6-3 illustrates diode types and polarity markings that are used in the instrument.

**Transistor and Integrated Circuit Electrode Configuration.** Lead identification for the transistors is shown in Fig. 6-4. IC pin-out diagrams are shown, when necessary, on the back of the adjoining pullout schematic diagram.

### Finding Faulty Semiconductors

Semiconductor failures account for the majority of electronic equipment failures. Most semiconductor devices (transistors and IC's) are socket-mounted. Substitution is often the most practical means for checking their performance. The following guidelines should be followed when substituting these components.

- 1 First determine that circuit voltages are safe for the substituted component so the replacement will not be damaged.

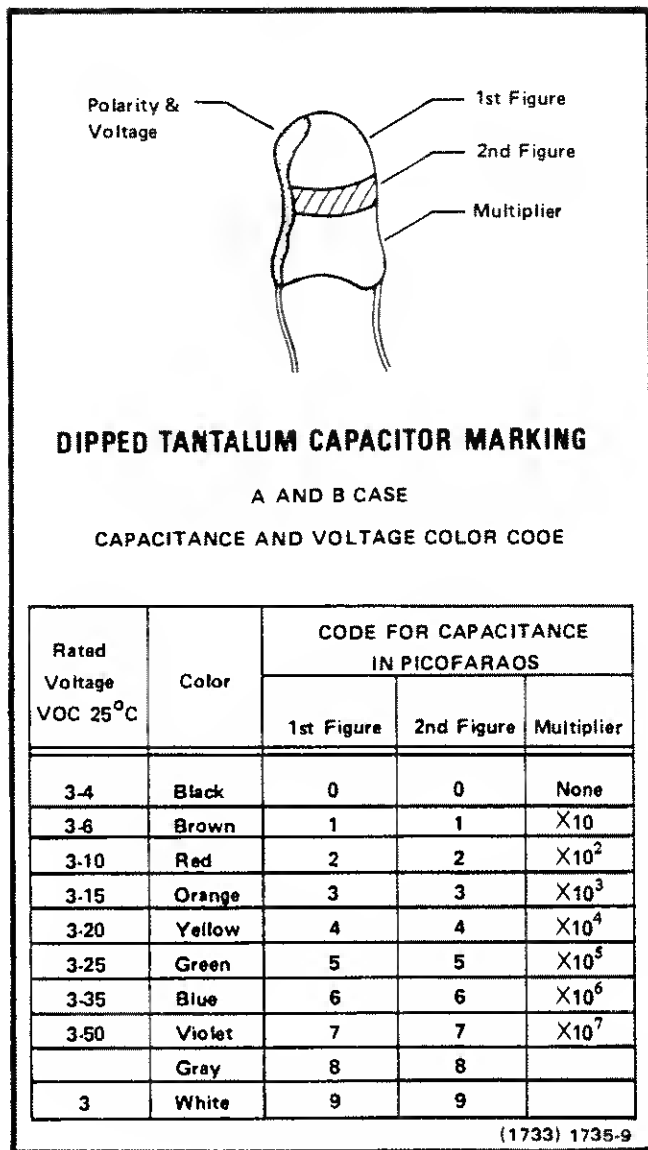


Fig. 6-2. Color code for some tantalum capacitors.

2. Use only good components for substitution.
3. Turn the power off before a component is substituted.
4. Be sure the component (transistor or IC) is inserted properly in the socket (see Fig. 6-4 or the manufacturers data sheet).
5. After the operational check, return the good components to their original sockets to reduce calibration time and run-in period.

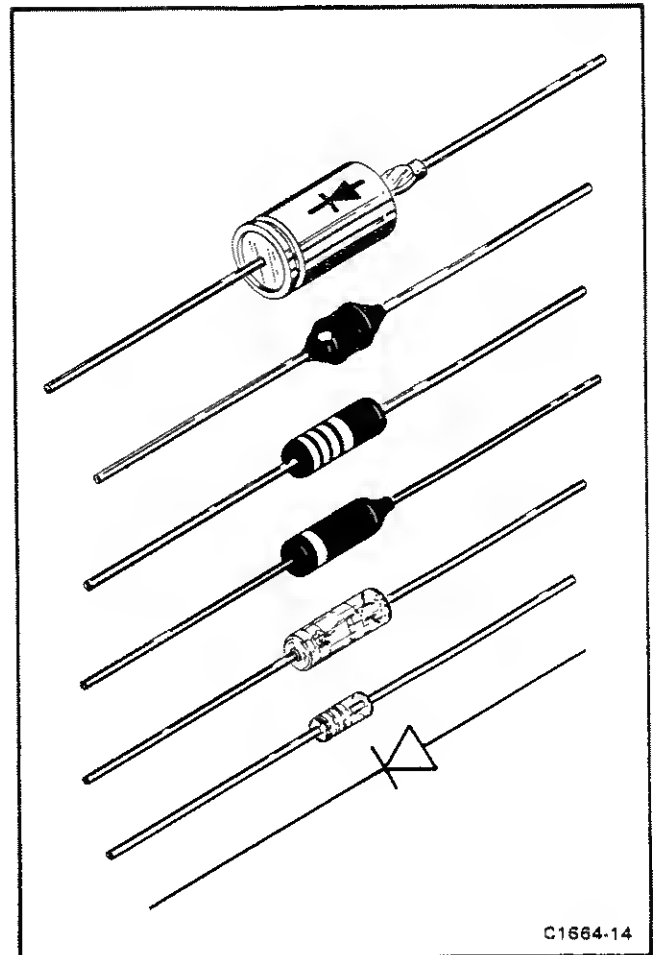


Fig. 6-3. Diode polarity markings.

**NOTE**

If a substitute is not available, check the transistor with a dynamic tester such as the Tektronix Type 576 Curve Tracer or the 5CT1N Curve Tracer for the 5000-Series Mainframe. Static-type testers, such as a ohmmeter, can be used to check the resistance ratio across some semiconductor junctions if no other method is available. Use the high resistance ranges ( $R \times 1000$  or higher) so the external test current is limited to less than 6 mA. If uncertain, measure the external test current with an ammeter. Resistance ratio across the base-to-emitter or base-to-collector junction usually runs 100:1 or higher. The ratio is measured by connecting the meter leads across the terminals, noting the reading, then reversing the leads and note the second reading.

**Diode Checks.** Most diodes can be checked in the circuit by taking measurements across the diode and comparing these with voltages listed on the diagram

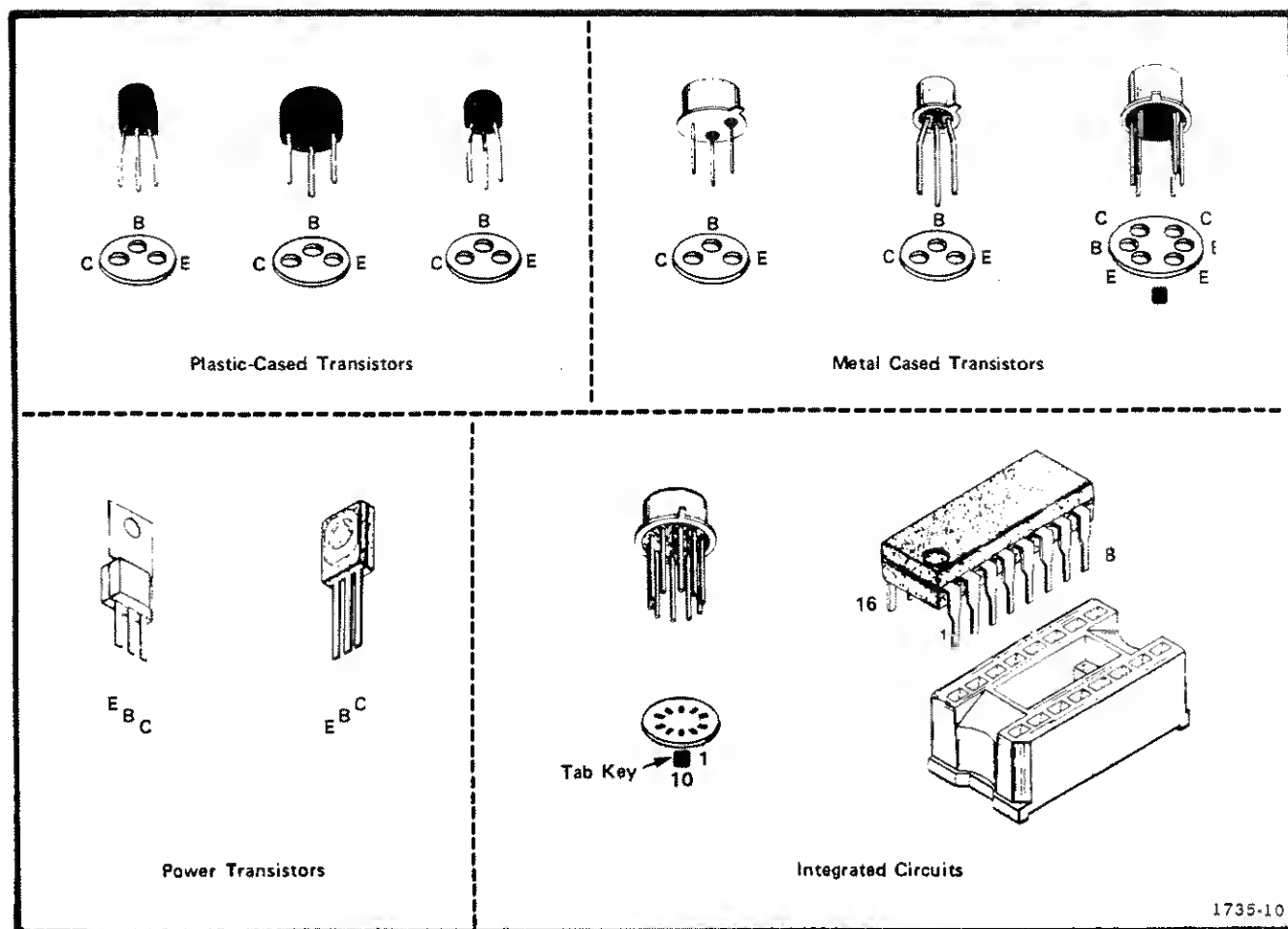


Fig. 6-4. Electrode configuration for semiconductor components.

Forward-to-back resistance ratios can usually be taken by referring to the schematic and pulling appropriate transistors and pin connectors to remove low resistance loops around the diode.

### CAUTION

*Do not use an ohmmeter scale with a high external current to check the diode junction. Do not check the forward-to-back resistance ratio of mixer diodes.*

**Integrated Circuit (IC) Checks.** Integrated circuits are most easily checked by direct replacement. When substitution is impossible, check input and output signal states as described in the Circuit Description and on the diagram. Use care when checking the signal state, at the pins, so adjacent leads are not shorted. A convenient means of clipping a test probe to the multi-pin IC's is with an IC test clip. This device also serves as an extracting tool. Lead configuration and data for the IC's, used in this instrument are provided on the inside fold of the schematic or the back of the previous schematic.

Check calibration and performance after a faulty component has been replaced.

If the above procedure fails to locate the trouble, a more detailed analysis must be performed. The Circuit Description section describes the operational theory of each circuit and may aid to further evaluate the problem.

### General Troubleshooting Techniques

The following procedure is recommended to isolate a problem and expedite repairs.

1. Ensure that the malfunction exists in the instrument. Check the operation of associated equipment and the operating procedure of the TR 502 (see Operating Instructions).

2. Determine and evaluate all trouble symptoms. Try to isolate the problem to a circuit or assembly. The block



diagram in the Diagrams section can aid in signal tracing and circuit isolation. It and the diagrams show the signal levels required at various points to produce full screen deflection.

### CAUTION

*When measuring voltages and waveforms, use extreme care in placing meter leads or probes. Because of high component density and limited access within the instrument, an inadvertent movement of the leads or probe could cause a short circuit. This may produce transient voltages which can destroy many components.*

3. Try to evaluate and determine the characteristics of the problem, such as component failure or calibration, and the functional area most likely at fault.

4. Visually inspect the area for such defects as broken or loose connections, improperly seated components, overheated or burned components, chafed insulation, etc. Repair or replace all obvious defects. In the case of overheated components, try to determine the cause of the overheated condition and correct before applying power.

5. By successive electrical checks, locate the problem. At this time an oscilloscope is a valuable test item for evaluating circuit performance. If applicable, check the calibration adjustments however, before changing an adjustment, note its position so it can be returned to the original setting. This will facilitate recalibration after the trouble has been located and repaired.

6. Determine the extent of the repair needed; if complex, we recommend contacting your local Tektronix Field Office or representative. If the damage is minor, such as a component replacement, see the Parts List for replacement procedures of the assemblies and sub-assemblies as described under Corrective Maintenance.

## CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques and procedures required to replace components and assemblies in this instrument are described here.

### Obtaining Replacement Parts

Most electrical and mechanical parts are available through your local Tektronix Field Office or representative. The Parts List section contains information on how

to order these replacement parts. Many standard electronic components may be obtained locally in less time than that required to order from Tektronix, Inc. It is best to duplicate the original component as closely as possible. Parts orientation and lead dress should be duplicated because orientation may affect circuit interaction. If a component you have ordered has been replaced with a new or improved part, your local Field Office or representative will contact you concerning the change in the part number. After repair, the circuits may need recalibration.

**Parts Repair and Exchange Program.** Tektronix repair centers provide replacement or repair service on major assemblies as well as the unit. Return the instrument or assembly to your local Field Office for this service. See Repackaging Instructions in Section 1 for shipping information.

### Soldering Technique

### CAUTION

*Disconnect the instrument from its power source before replacing or soldering components.*

Because it is easy to damage the plating in the board holes that the component is soldered to, we recommend cutting the old component free and leaving some lead length to solder the new component leads to. If the leads are pulled through the plated holes use caution. Excessive heat or bent leads may damage the plating. Use a 15 watt pencil-type iron, straighten the lead on the back side of the board, then when the solder melts, gently pull the unsoldered lead through the hole. A desoldering tool should be used to remove the old solder.

### Transistor and Integrated Circuit Replacement

Transistors and IC's should not be replaced unless they are actually defective. When they are removed, during routine maintenance, return them to their original sockets. Unnecessary replacement or switching of semiconductor devices may affect the instrument adjustment. When an active device is replaced, check the operation of the circuit affected.

### CAUTION

*POWER switch must be turned off before removing or replacing semiconductors.*

Replacement semiconductors should be of the original type or a direct replacement. Fig. 6-4 shows the lead configuration of the semiconductors used in this instrument.

An extracting tool should be used to remove the multi-pin integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the IC. Try to avoid having one end of the IC disengage from the socket before the other.

### Replacing the Square Pin for the Multi-Pin Connectors

#### NOTE

*A pin replacement kit including necessary tools, instructions, and replacement pins is available from Tektronix, Inc. Order Tektronix Part No. 040-0542-00.*

It is important not to damage or disturb the ferrule when removing the old stub of a broken pin. The ferrule is pressed into the circuit board and provides a base for soldering the pin connector.

If the broken stub is long enough, grasp it with needle-nose pliers, applying heat with a small soldering iron to the pin base of the ferrule and pull the old pin out. If the broken stub is too short to grasp with pliers, use a small dowel (0.028 inch in diameter) to push the pin out. Use a pair of diagonal cutters to remove the ferrule from the new pin then insert the pin into the old ferrule and solder to both sides of the ferrule.

### Interconnecting Cable and Pin Connector Replacement

The interconnecting cable assemblies are factory assembled. They consist of machine installed pin connectors mounted in plastic holders. The plastic holders are easily replaced as individual items, but if the connectors are faulty the entire cable should be replaced.

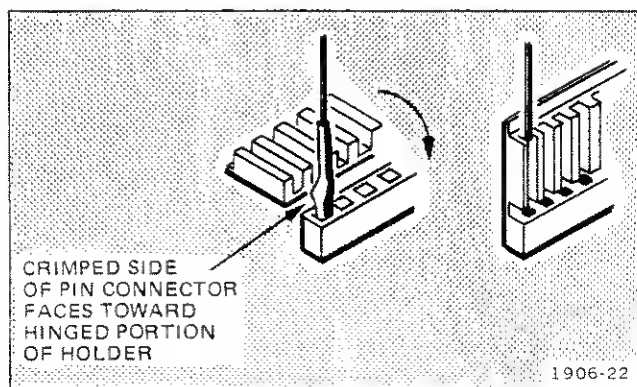


Fig. 6-5. Pin connector replacement.

It is possible for the pin connectors to become dislodged from the plastic holders. If this happens, the connector can be reinstalled as follows (see Fig. 6-5):

1. Bend grooved portion of holder away from cable as shown.

2. Re-insert the connector into its hole in the plug-in portion of the holder. Wires are positioned in the holder according to color-code system (see note below).

#### NOTE

*Holder positions are numbered (number one is identified with a triangle). The wires are EIA color coded to match the numbers on the holder. For example, brown stripe for position 1 (triangle), red stripe for position 2, yellow stripe for position 4, etc.*

3. Bend grooved part of holder so that connector is inserted into groove.

When plugging connector holders on to board pins, be sure to match the triangle mark on the holder with the triangle mark on the circuit board.

## REPLACING ASSEMBLIES

The modular construction of the TR 502 allows ready access to all circuit boards. In some cases, it may be advantageous to replace the completely wired circuit board (part numbers are provided in the Electrical and Mechanical Parts List). The exploded drawings associated with the Mechanical Parts List (located at the rear section of the manual) may be helpful in the disassembly or replacement of assemblies or sub-assemblies.

### Replacing Microwave Assemblies

**Tools Required.** Open-end offset 5/16 inch wrenches, such as those recommended for the 7L13 or 7L12 rf connectors, are required to loosen or tighten the nuts for the semi-rigid coaxial connectors.

#### General Procedures.

#### CAUTION

*The connectors of the semi-rigid cables should be tightened so they are just snug or slightly more than finger tight. If a small torque does not loosen the nut, a second wrench should be used to hold the rigid portion of the connector while loosening the nut.*

1. Separate the two sections of the instrument as shown in Fig. 6-6.

2. Loosen and remove the semi-rigid coaxial cable connectors to the applicable assembly, then, if the assembly has soldered connectors and ribbon cable unplug the multi-pin plug at the circuit board.

3. Loosen and remove the mounting screws and remove the assembly.

4. Reverse this procedure to replace the assembly.

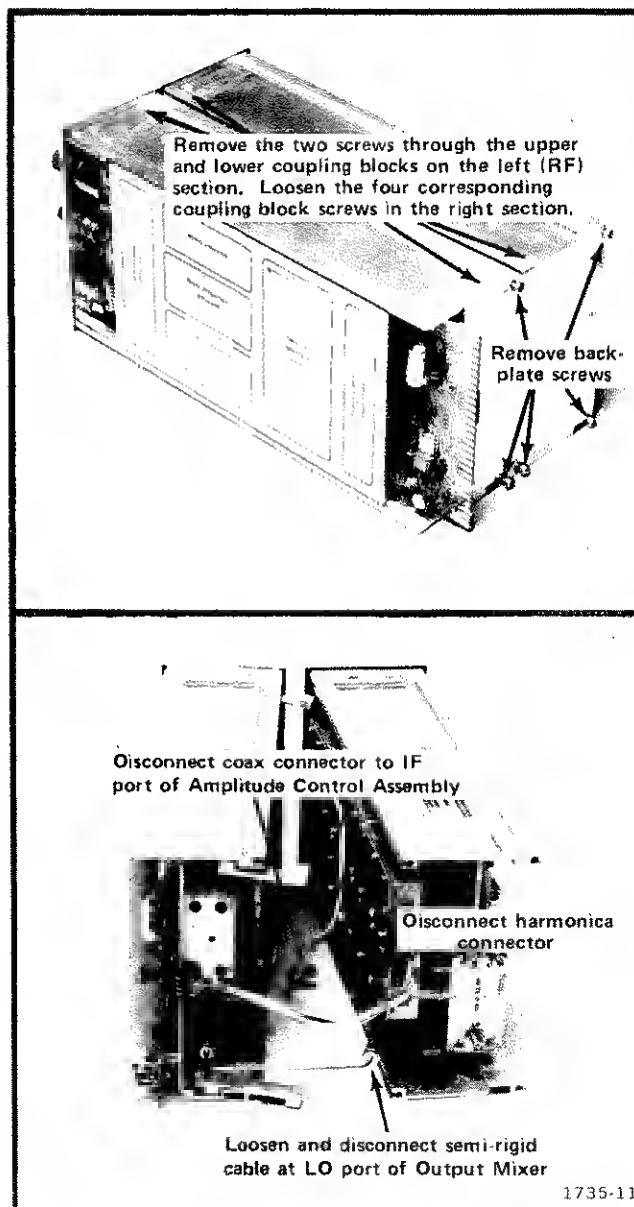


Fig. 6-6. Procedure for separating the two sections of the TR 502.

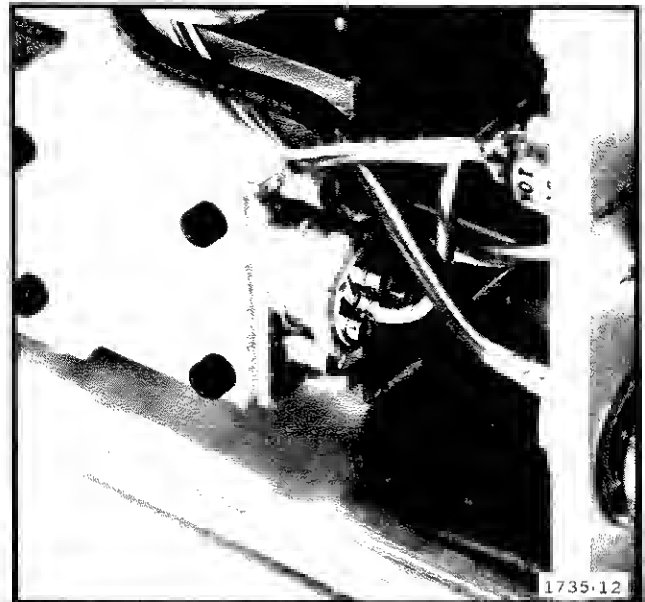


Fig. 6-7. Typical position for the mixer assembly in the 2.2 GHz filter assembly.

#### Replacing the 2.2 GHz Four Cavity Filter Assembly (A320) or the Mixer Assembly (A310)

The filter assembly is pretuned at the factory so only slight adjustments are required after it is installed. The mixer affects filter response, therefore, if either assembly is replaced, retuning the filter and adjusting the mixer coupling will be required. The orientation of the mixer affects mixer balance and the suppression of a 2.2 GHz spur. If the mixer is positioned as shown in Fig. 6-7, the spur will usually be down 70 dB or more. If spurs should appear, adjust the orientation to minimize.

The following equipment is required to tune the filter/mixer combination.

1. Power Supply with variable output from 0 to 10 V at 0 to 40 mA: Tektronix PS 501 of the TM 500-Series.
2. Adapter: BNC female to subminiature (SEALEC-TRO) female: Tektronix Part No. 175-1162-00 or SEALEC-TRO Part No. 51-077-6801.
3. Adapter: BNC male to BNC male: Short length of 50  $\Omega$  coaxial cable with BNC connectors or an adapter, Tektronix Part Number 103-0028-00.
4. Adapter: N female to BNC male. Tektronix Part No. 103-0058-00.

1. Remove and Replace the Filter Assembly.

a. Disconnect the two semi-rigid cables and remove the mounting screws.

b. Remove the filter mixer assembly.

c. Remove the mixer assembly and install it in the replacement filter assembly. Position the mixer assembly as illustrated in Fig. 6-7.

**CAUTION**

*Do not push the mixer assembly all the way into the filter cavity because this may damage the diodes.*

d. Install the new assembly by reversing the removal procedure and reconnect the semi-rigid cables.

2. Filter Alignment Procedure.

**CAUTION**

*The response of the filter or signal amplitude through the filter is a function of all adjustments. All must be very close to optimum. If the adjustments are moved to where the signal is no longer seen, there is virtually no way to tune the filter without special equipment.*

a. Separate the two sections as previously described and position the two sections so the filter adjustments are accessible. Remove P446 (Tune Voltage Line, Fig. 6-8). Reconnect P370 and P210 to the Mother board and Leveling Loop and Bias board. Connect the + terminal of an external power supply to the Tune Voltage terminal of the 2.095 GHz Oscillator and Amplitude Control microwave assembly or the oscillator pin side of J446 (see Fig. 6-9). Adjust the power supply output for +7 volt then switch the TM 500 mainframe power on.

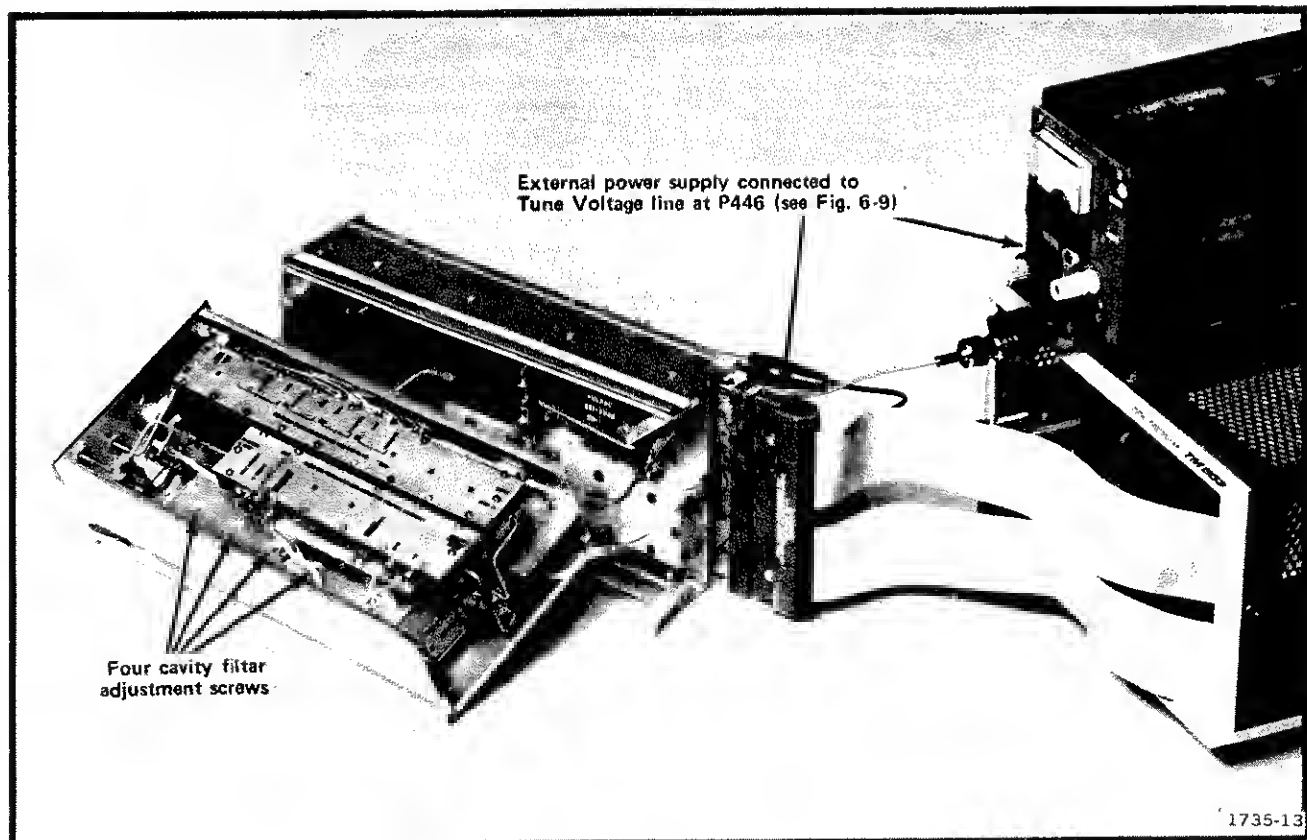


Fig. 6-8. Positioning the TR 502 to adjust the 2.2 GHz filter and mixer assemblies.

b. Connect the 2nd LO output of the spectrum analyzer to the 2nd LO INPUT of the TR 502.

c. Apply the 50 MHz Calibrator signal to the RF Input of the spectrum analyzer and set the Frequency Span/Div to 5 MHz with a Resolution of 300 kHz. Using the 100 MHz signal as a reference, tune the Center Frequency to 105 MHz by tuning the 100 MHz signal one division to the left of center. After the analyzer center frequency has been set to 105 MHz, disconnect the Calibrator signal to the RF Input.

d. Use a short 50  $\Omega$  cable and adapter to connect the IF Output of the 2.095 GHz Oscillator and Amplitude Control microwave assembly to the RF Input of the spectrum analyzer.

e. Adjust the voltage of the power supply to tune the 2.095 GHz oscillator so the 105 MHz IF signal is centered on screen.

f. Move the cable from the spectrum analyzer (7L13 or 7L12) 2nd LO Out to the 1st LO Out so the 1st LO Out signal is now applied to the TR 502 2nd LO IN connector.

g. Set the spectrum analyzer Frequency Span/Div to 5 MHz, Resolution to 3 MHz and the Display Mode to 2 dB/Div.

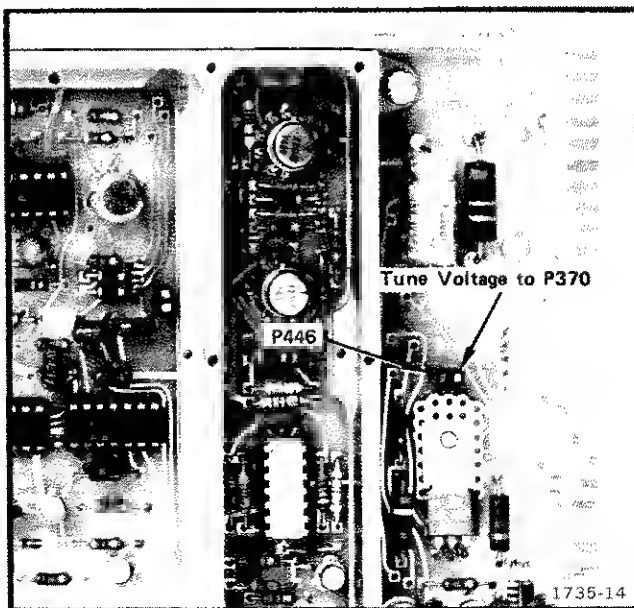


Fig. 6-9. Location of P446 on the Mother board.

h. Maximize the filter response signal amplitude by adjusting the power supply voltage. Do not exceed 20 volts.

i. Loosen the mixer clamp, so the coupling and orientation can be adjusted, then position the mixer as indicated in Fig. 6-7 (apex of the 3 screws up).

j. Adjust the four cavities and the mixer coupling for the best flat-top bandpass response. Keep the response centered at the reference frequency as you adjust and be very careful to not lose the signal. Typical responses are shown in Fig. 6-10.

This completes the calibration of the TR 502. Performing the verification checks in the Performance Check section to ensure that it meets specifications.

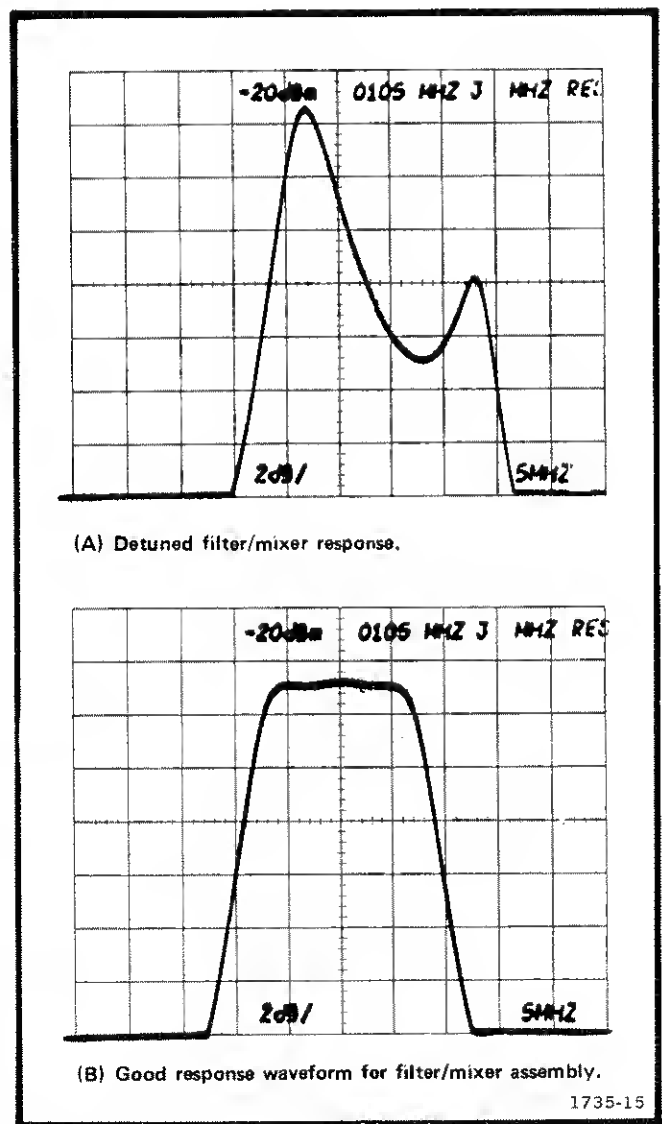


Fig. 6-10. Typical response characteristics of the filter/mixer assemblies.



# OPTION INFORMATION

Your instrument may be equipped with one or more options. This section describes those options, or directs the reader to where the option is documented.





# REPLACEABLE ELECTRICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

X000      Part first added at this serial number  
00X      Part removed after this serial number

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICON	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

# CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
01002	GENERAL ELECTRIC CO., INDUSTRIAL AND POWER CAPACITOR PRODUCTS DEPT.	JOHN ST. 1201 2ND ST. SOUTH	HUDSON FALLS, NY 12839 MILWAUKEE, WI 53204
01121	ALLEN-BRADLEY CO.		
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P. O. BOX 5012 ROUTE 202	DALLAS, TX 75222 SOMERVILLE, NY 08876
02735	RCA CORP., SOLID STATE DIVISION		
03508	GENERAL ELECTRIC CO., SEMI-CONDUCTOR PRODUCTS DEPT.	ELECTRONICS PARK 21282 LAGUNA CANYON RD.	SYRACUSE, NY 13201 LAGUNA BEACH, CA. 92652
04423	TELONIC INDUSTRIES, INC.		
04713	MOTOROLA, INC., SEMICONDUCTOR PRODUCTS DIV.	5005 E. MCDOWELL RD.	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS ST. 12515 CHADRON AVE.	MOUNTAIN VIEW, CA 94042 HAWTHORNE, CA 90250
07910	TELEDYNE SEMICONDUCTOR	580 PLEASANT ST.	WATERTOWN, MA 02172
12969	UNITRODE CORP.	652 MITCHELL ROAD	NEWBURY PARK, CA 91320
14099	SEMTECH CORP.	SKYLINE DRIVE	MONTVILLE, NJ 07045
18203	ENGELMANN MICROWAVE CO.		TOKYO, JAPAN
18657	TOKYO SHIBAURA ELECTRIC CO., LTD.	825 STEWART DR.	SUNNYVALE, CA 94086
21847	AERTECH	2900 SAN YSIDRO WAY	SANTA CLARA, CA 95051
27014	NATIONAL SEMICONDUCTOR CORP.		NORTH ADAMS, MA 01247
56289	SPRAGUE ELECTRIC CO.	2545 W. GRANDVIEW BLVD.	ERIE, PA 16512
71034	BLILEY ELECTRIC CO.	644 W. 12TH ST.	ERIE, PA 16512
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	2500 HARBOR BLVD.	FULLERTON, CA 92634
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.		
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST. P. O. BOX 500	PHILADELPHIA, PA 19108 BEAVERTON, OR 97077
80009	TEKTRONIX, INC.		
82647	TEXAS INSTRUMENTS, INC., CONTROL PRODUCTS DIV.	34 FOREST ST.	ATTLEBORO, MA 02703

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A60	119-0738-01		AMPLIFIER ASSY:2.1-3.9 GHZ	80009	119-0738-01
A70	119-0633-01		ISOLATOR,RF REF:2-4 GHZ	21847	ASI2040
A80	015-1027-00		FILTER,LOWPASS:2.5 GHZ	80009	015-1027-00
A90	119-0751-00		BANDPASS FILTER:2.1-3.9 GHZ	80009	119-0751-00
A100	119-0633-00		ISOLATOR,RF,REF:2-4 GHZ	21847	ASI2040
A110	119-0732-00		MIXER ASSEMBLY:OUTPUT	80009	119-0732-00
A120	119-0736-00		HYB CKT ASSY:0.1-1.8 GHZ AMPL/DET ASSY	80009	119-0736-00
A130	119-0740-00		STEP ATTENUATOR:0-59DB 50 OHM	04423	8142S-101
A140	119-0737-00		HYB CKT ASSY:2.095 GHZ OSC AND AMPL CONTROL	80009	119-0737-00
A150	670-4145-00		CKT BOARD ASSY:LEVELING LOOP AND BIAS	80009	670-4145-00
A320	119-0735-01		FILTER ASSEMBLY:2.2 GHZ 4 CAVITY FILTER	80009	119-0735-01
A350A1	670-4144-00		CKT BOARD ASSY:MOTHER	80009	670-4144-00
A350A2	670-4141-00		CKT BOARD ASSY:105 MHZ AMPLIFIER	80009	670-4141-00
A350A3	670-4143-00		CKT BOARD ASSY:52.5 MHZ OSCILLATOR	80009	670-4143-00
A350A4	670-4142-00		CKT BOARD ASSY:Ø FREQUENCY DETECTOR	80009	670-4142-00
C150	283-0129-00		CAP.,FXD,CER DI:0.56UF,20%,100V	56289	275C7
C162	283-0129-00		CAP.,FXD,CER DI:0.56UF,20%,100V	56289	275C7
C174	283-0129-00		CAP.,FXD,CER DI:0.56UF,20%,100V	56289	275C7
C186	283-0129-00		CAP.,FXD,CER DI:0.56UF,20%,100V	56289	275C7
C202	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C210	283-0341-00		CAP.,FXD,CER DI:0.047UF,10%,100V	72982	8131N145W5R473K
C212	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C218	283-0346-00		CAP.,FXD,CER DI:D.47UF,+80-20%,100V	72982	8131-M100651474Z
C226	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C232	283-0129-00		CAP.,FXD,CER DI:0.56UF,20%,100V	56289	275C7
C250	29D-0340-00		CAP.,FXD,ELCTLT:10UF,10%,50V	56289	109D106X9050C2
C254	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C26D	290-0340-00		CAP.,FXD,ELCTLT:1DUF,1D%,50V	56289	109D106X9050C2
C262	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C360	283-0197-00		CAP.,FXD,CER DI:470PF,5%,100V	72982	8121N064C0G471J
C362	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C364	281-0752-00		CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C366	281-0752-00		CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C374	283-0114-00		CAP.,FXD,CER DI:0.0015UF,5%,200V	72982	805-5098152J
C384	290-0513-00		CAP.,FXD,ELCTLT:510UF,+75-10%,25V	01002	69F2336G7
C386	281-0752-00		CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C388	281-0752-00		CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C390	281-0752-00		CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C404	283-0060-00		CAP.,FXD,CER DI:100PF,5%,200V	72982	855-535U2J101J
C408	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C410	283-0167-00		CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N147W5R104K
C412	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C420	281-0752-00		CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C422	281-0752-00		CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C424	285-0882-00		CAP.,FXD,PLSTC:0.047UF,10%,100V	56289	LP66A1B473K001
C428	285-0882-00		CAP.,FXD,PLSTC:0.047UF,10%,100V	56289	LP66A1B473K001
C432	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C450	283-0114-00		CAP.,FXD,CER DI:0.0015UF,5%,200V	72982	805-5098152J
C452	283-0103-00		CAP.,FXD,CER DI:180PF,5%,500V	56289	40C638
C454	283-0116-00		CAP.,FXD,CER DI:820PF,5%,500V	72982	801-5478821J
C456	290-0512-00		CAP.,FXD,ELCTLT:22UF,20%,15V	56289	196D226X0015KA1
C466	283-0196-00		CAP.,FXD,CER DI:270PF,10%,50V	72982	8101A058W5R271K
C480	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
C490	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100651474Z
C494	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100651474Z
C498	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100651474Z
C500	283-0103-00		CAP., FXD, CER DI: 180PF, 5%, 500V	56289	40C638
C502	283-0114-00		CAP., FXD, CER DI: 0.0015UF, 5%, 200V	72982	805-509B152J
C506	283-0103-00		CAP., FXD, CER DI: 180PF, 5%, 500V	56289	40C638
C508	283-0103-00		CAP., FXD, CER DI: 180PF, 5%, 500V	56289	40C638
C514	283-0103-00		CAP., FXD, CER DI: 180PF, 5%, 500V	56289	40C638
C516	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100651474Z
C518	283-0103-00		CAP., FXD, CER DI: 180PF, 5%, 500V	56289	40C638
C522	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100651474Z
C524	281-0167-00		CAP., VAR, CER DI: 9-45PF, 200V	72982	538-011-D 9-45
C526	281-0508-00		CAP., FXD, CER DI: 12PF, +/-0.6PF, 500V	72982	301-000COG0120J
C528	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100651474Z
C532	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100651474Z
C542	283-0239-00		CAP., FXD, CER DI: 0.022UF, 10%, 50V	72982	8131N075WR5223K
C544	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100651474Z
C550	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100651474Z
CR212	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	07910	1N4152
CR214	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	07910	1N4152
CR216	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	07910	1N4152
CR250	152-0040-00		SEMICOND DEVICE: SILICON, 600V, 1A	14099	SC6
CR370	152-0242-00		SEMICOND DEVICE: SILICON, 225V, 200MA	12969	NDP341
CR372	152-0242-00		SEMICOND DEVICE: SILICON, 225V, 200MA	12969	NDP341
CR395	152-0333-00		SEMICOND DEVICE: SILICON, 55V, 200MA	80009	152-0333-00
CR428	152-0574-00		SEMICOND DEVICE: SILICON, 120V	80009	152-0574-00
CR456	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	07910	1N4152
CR466	152-0141-02		SEMICOND DEVICE: SILICON, 30V, 150MA	07910	1N4152
CR480	152-0061-00		SEMICOND DEVICE: SILICON, 175V, 100MA	80009	152-0061-00
CR526	152-0595-00		SEMICOND DEVICE: VOLT-VAR CAP, 15%, 12PIV	04713	MV1404
L250	108-0395-00		COIL, RF: 64UH	80009	108-0395-00
L490	108-0537-00		COIL, RF: 200UH	80009	108-0537-00
L526	108-0707-00		COIL, RF: 150NH	80009	108-0707-00
L540	108-0724-00		COIL, RF: 12.6UH, TOROIDAL	80009	108-0724-00
P120	015-1025-01		TERMINATION COAX: MM MALE, 50 OHM W/CH	18203	T186CS
Q210	136-0514-00		SOCKET, PLUG-IN: MICROCIRCUIT, 8 CONTACT	82647	G930802
Q390	151-0364-00		TRANSISTOR: SILICON, PNP	03508	X43C181
Q395	151-0301-00		TRANSISTOR: SILICON, PNP	04713	2N2907A
Q410	151-0134-00		TRANSISTOR: SILICON, PNP	04713	SM3195
Q420	151-0286-00		TRANSISTOR: SILICON, NPN	18657	2SC515
Q430	151-0508-00		TRANSISTOR: SILICON, NPN, UNIJUNCTION	03508	2N6027
Q440	151-0302-00		TRANSISTOR: SILICON, NPN	04713	2N2222A
Q445	151-0302-00		TRANSISTOR: SILICON, NPN	04713	2N2222A
Q450	151-0302-00		TRANSISTOR: SILICON, NPN	04713	2N2222A
Q455	151-0302-00		TRANSISTOR: SILICON, NPN	04713	2N2222A
Q480	151-0136-00		TRANSISTOR: SILICON, NPN	02735	35495
R5	311-0645-00		RES., VAR, NONWIR: 50K OHM, 20%, 0.5W	01121	GS1N048S503MA
R10	311-1341-00		RES., VAR, NONWIR: 10K OHM, 5%, 2W	01121	534-9608103J
R20	311-1298-00		RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	01121	W-7909
R150	321-0167-00		RES., FXD, FILM: 536 OHM, 1%, 0.125W	75042	CEATO-5360F
R152	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R154	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R156	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R158	315-0272-00		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R160	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R162	321-0167-00		RES.,FXD,FILM:536 OHM,1%,0.125W	75042	CEATO-5360F
R164	315-0184-00		RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
R166	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R168	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R170	315-0272-00		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R172	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R174	321-0138-00		RES.,FXD,FILM:267 OHM,1%,0.125W	75042	CEATO-2670F
R176	315-0184-00		RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
R178	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R180	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R182	315-0272-00		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R184	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R188	315-0184-00		RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
R190	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R192	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R194	315-0272-00		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R196	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R200	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R202	321-0422-00		RES.,FXD,FILM:243K OHM,1%,0.125W	75042	CEATO-2433F
R204	315-0243-00		RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R206	315-0912-00		RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R207	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R208	321-0251-00		RES.,FXD,FILM:4.02K OHM,1%,0.125W	75042	CEATO-4021F
R209	315-0821-00		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R210	321-0222-00		RES.,FXD,FILM:2K OHM,1%,0.125W	75042	CEATO-2001F
R211	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R212	315-0683-00		RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R214	321-0228-00		RES.,FXD,FILM:2.32K OHM,1%,0.125W	75042	CEATO-2321F
R215	311-1268-00		RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0
R218	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R220	311-1271-00		RES.,VAR,NONWIR:50K OHM,10%,0.50W	73138	62PT-354-0
R221	321-0356-00		RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEATO-4992F
R222	311-1271-00		RES.,VAR,NONWIR:50K OHM,10%,0.50W	73138	62PT-354-0
R225	311-1270-00		RES.,VAR,NONWIR:25K OHM,10%,0.50W	73138	62PT-353-0
R226	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R228	321-0347-00		RES.,FXD,FILM:40.2K OHM,1%,0.125W	75042	CEATO-4022F
R232	315-0184-00		RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
R234	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R236	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R238	315-0272-00		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R240	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R242	321-0147-00		RES.,FXD,FILM:332 OHM,1%,0.125W	75042	CEATO-3320F
R250	321-0345-00		RES.,FXD,FILM:38.3K OHM,1%,0.125W	75042	CEATO-3832F
R252	321-0364-00		RES.,FXD,FILM:60.4K OHM,1%,0.125W	75042	CEATO-6042F
R254	315-0362-00		RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R256	315-0203-00		RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R258	315-0182-00		RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R260	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R261	321-0239-00		RES.,FXD,FILM:3.01K OHM,1%,0.125W	75042	CEATO-3011F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R262	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R350	315-0271-00		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R352	315-0301-00		RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R354	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R356	307-0052-00		RES.,FXD,CMPSN:3 OHM,5%,0.50W	01121	EB30G5
R358	321-0279-00		RES.,FXD,FILM:7.87K OHM,1%,0.125W	75042	CEATO-7871F
R360	321-0275-00		RES.,FXD,FILM:7.15K OHM,1%,0.125W	75042	CEATO-7151F
R362	321-0164-00		RES.,FXD,FILM:499 OHM,1%,0.125W	75042	CEATO-4990F
R364	321-0270-00		RES.,FXD,FILM:6.34K OHM,1%,0.125W	75042	CEATO-6341F
R370	315-0620-00		RES.,FXD,CMPSN:62 OHM,5%,0.25W	01121	CB6205
R372	315-0271-00		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R374	321-0222-00		RES.,FXD,FILM:2K OHM,1%,0.125W	75042	CEATO-2001F
R376	321-0260-00		RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEATO-4991F
R378	315-0431-00		RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R380	308-0677-00		RES.,FXD,WW:1 OHM,5%,2W	75042	BWH-1R000J
R382	315-0562-00		RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R390	301-0392-00		RES.,FXD,CMPSN:3.9K OHM,5%,0.50W	01121	EB3925
R392	301-0121-00		RES.,FXD,CMPSN:120 OHM,5%,0.50W	01121	EB1215
R394	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
R396	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R398	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R400	321-0295-00		RES.,FXD,FILM:11.5K OHM,1%,0.125W	75042	CEATO-1152F
R402	321-0239-00		RES.,FXD,FILM:3.01K OHM,1%,0.125W	75042	CEATO-3011F
R404	321-0247-00		RES.,FXD,FILM:3.65K OHM,1%,0.125W	75042	CEATO-3651F
R406	321-0239-00		RES.,FXD,FILM:3.01K OHM,1%,0.125W	75042	CEATO-3011F
R408	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R410	315-0301-00		RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R412	315-0271-00		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R414	315-0201-00		RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R420	321-0282-00		RES.,FXD,FILM:8.45K OHM,1%,0.125W	75042	CEATO-8451F
R422	321-0282-00		RES.,FXD,FILM:8.45K OHM,1%,0.125W	75042	CEATO-8451F
R424	321-0222-00		RES.,FXD,FILM:2K OHM,1%,0.125W	75042	CEATO-2001F
R426	315-0181-00		RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R428	321-0222-00		RES.,FXD,FILM:2K OHM,1%,0.125W	75042	CEATO-2001F
R430	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R432	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R434	315-0623-00		RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R436	315-0243-00		RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R438	315-0434-00		RES.,FXD,CMPSN:430K OHM,5%,0.25W	01121	CB4345
R440	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R441	315-0150-00		RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R442	315-0150-00		RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R444	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R446	315-0203-00		RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R448	315-0682-00		RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R450	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R451	315-0470-00		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R452	315-0302-00		RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R453	315-0822-00		RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R454	315-0432-00		RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R455	156-0172-00		MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0172-00
R456	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R458	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035

Ckt No.	Tektronix Part No.	Serial/Model No. Eff      Dscont	Name & Description	Mfr Code	Mfr Part Number
R462	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R464	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R466	315-0202-00		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R470	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R472	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R474	315-0154-00		RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R475	311-1272-00		RES.,VAR,NONWIR:100K OHM,10%,0.50W	73138	62PT-355-0
R476	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R480	315-0150-00		RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R482	315-0392-00		RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R484	315-0271-00		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R494	315-0300-00		RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R498	315-0300-00		RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R500	315-0680-00		RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R502	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R504	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R506	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R508	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R510	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R512	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R514	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R516	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R518	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R520	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R521	317-0510-00		RES.,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R522	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R523	317-0510-00		RES.,FXD,CMPSN:51 OHM,5%,0.125W	01121	BB5105
R526	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
R532	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R536	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R538	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R539	315-0510-00		RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R542	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R544	315-0511-00		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R546	321-0097-00		RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEAT0-1000F
R548	321-0097-00		RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEAT0-1000F
R549	315-0511-00		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R550	315-0271-00		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R552	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R554	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R556	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R558	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R559	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
U150	156-0067-00		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U160	156-0067-00		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U170	156-0067-00		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U180	156-0067-00		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U200	156-0067-00		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U240	156-0067-00		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	B0009	156-0067-00
U250	156-0067-00		MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U350	156-0053-00		MICROCIRCUIT,LI:VOLTAGE REGULATOR	07263	U5R7723393
U365	156-0158-00		MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	B0009	156-0158-00
U370	156-0053-00		MICROCIRCUIT,LI:VOLTAGE REGULATOR	07263	U5R7723393
U390	156-0071-00		MICROCIRCUIT,LI:VOLTAGE REGULATOR	07263	723DC

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
U450	156-0058-00		MICROCIRCUIT,DI:HEX INVERTER	01295	SN7404N
U455	156-0172-00		MICROCIRCUIT,DI:DUAL MONOSTABLE MV	80009	156-0172-00
U460	156-0047-00		MICROCIRCUIT,DI:3-INPUT NAND GATE	80009	156-0047-00
U470	156-0096-00		MICROCIRCUIT,LI:VOLTAGE COMPARATOR	27014	LM311H
U500	156-0369-00		MICROCIRCUIT,LI:TRIPLE LINE REC	04713	MC10216L
U520	156-0308-00		MICROCIRCUIT,LI:QUAD DIFF LINE RECIEVER	04713	MC10115L
U540	156-0369-00		MICROCIRCUIT,DI:TRIPLE LINE RED	04713	MC10216L
U545	156-0518-00		MICROCIRCUIT,DI:PHASE FREQ DETECTOR	04713	MC12040L
U550	156-0230-00		MICROCIRCUIT,DI:DUAL D MA-SLAVE FLIP-FLOP	04713	MC10131L
VR250	152-0127-00		SEMICON D DEVICE:ZENER,0.4W,7.5V,5%	04713	1N755A
VR258	152-0461-00		SEMICON D DEVICE:ZENER,0.4W,6.2V,5%	04713	1N821
VR262	152-0461-00		SEMICON D DEVICE:ZENER,0.4W,6.2V,5%	04713	1N821
VR362	152-0461-00		SEMICON D DEVICE:ZENER,0.4W,6.2V,5%	04713	1N821
VR364	152-0461-00		SEMICON D DEVICE:ZENER,0.4W,6.2V,5%	04713	1N821
VR420	152-0304-00		SEMICON D DEVICE:ZENER,0.4W,20V,5%	04713	1N968B
W10	175-1746-00		CABLE ASSEMBLY:50 OHM COAX	80009	175-1746-00
W75	175-1720-00		CABLE ASSEMBLY:LOW PASS TO ISOLATOR	80009	175-1720-00
W85	175-1713-00		CABLE ASSEMBLY:INTERDIGITAL TO LOW PASS	80009	175-1713-00
W95	175-1716-00		CABLE ASSY:2-4 GHZ INTERDIGITAL TO ISOLATOR	80009	175-1716-00
W105	175-1721-00		CABLE ASSEMBLY:MIXER TO ISOLATOR	80009	175-1721-00
W130	175-1710-00		CABLE ASSEMBLY:	80009	175-1710-00
W135	175-1715-00		CABLE ASSEMBLY:	80009	175-1715-00
Y526	158-0098-00		XTAL UNIT,QTZ:52.5 AT 25 DEG SFS RES	71034	0BD

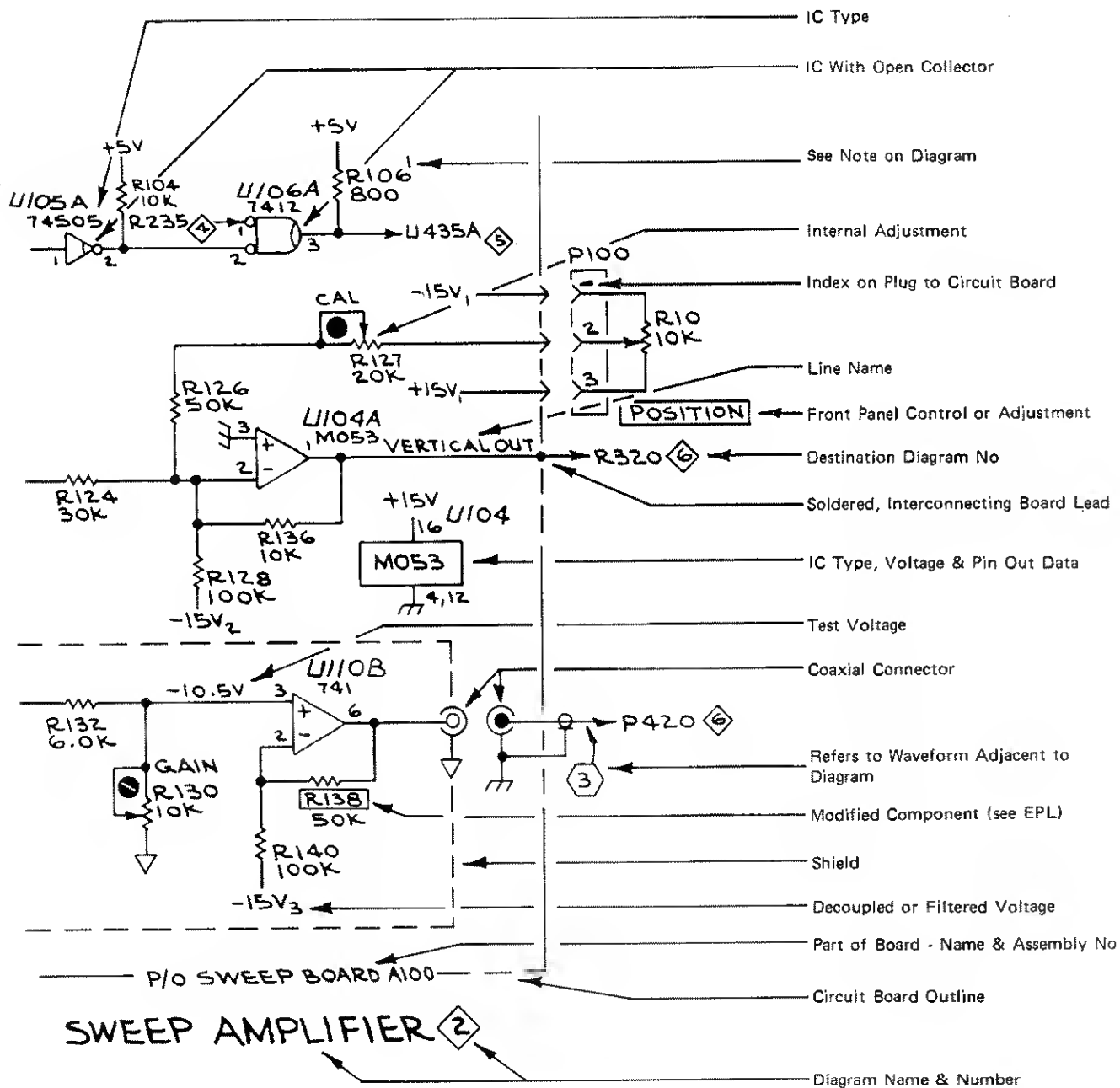


## DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

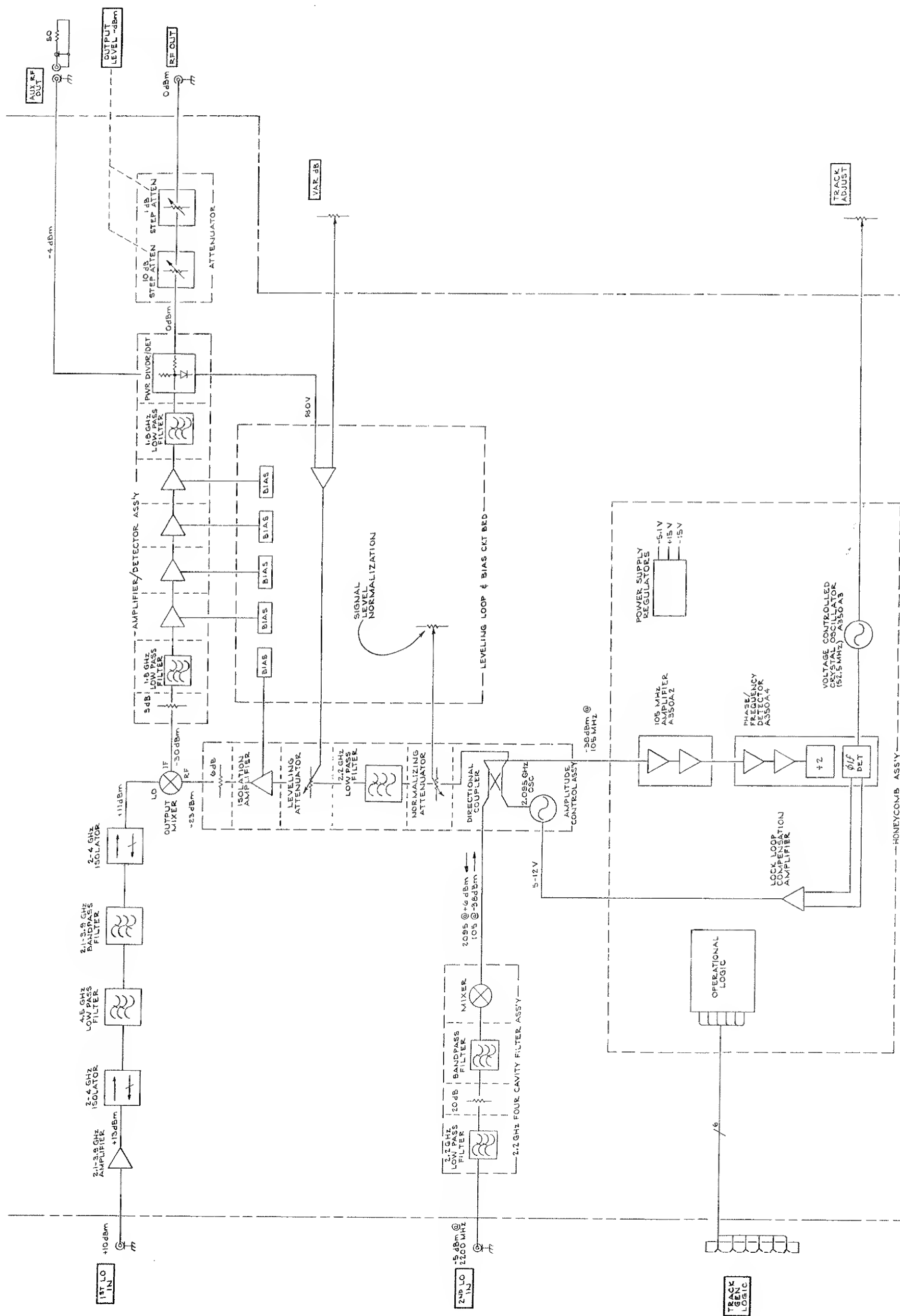
## Symbols and Reference Designators

Graphic symbols for electrical and logic symbols, used on the diagrams, are based on ANSI Y32.2, 1970, and ANSI Y32.14, 1973, "American National Standards Institute." Logic symbols depict the logic function of the device in positive logic. Copies of these standards can be obtained from the Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, N.Y., 11017. Exceptions and additions are shown on this sample diagram. These conform or are based on the manufacturers data sheet and industry trends.

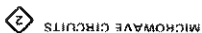
Resistor values are in ohms, unless noted otherwise, and the  $\Omega$  symbol is omitted. Capacitor values  $\geq 1$  (e.g. 10) are in picofarads (pF) and values  $< 1$  (e.g. 0.01) are in microfarads unless otherwise noted.







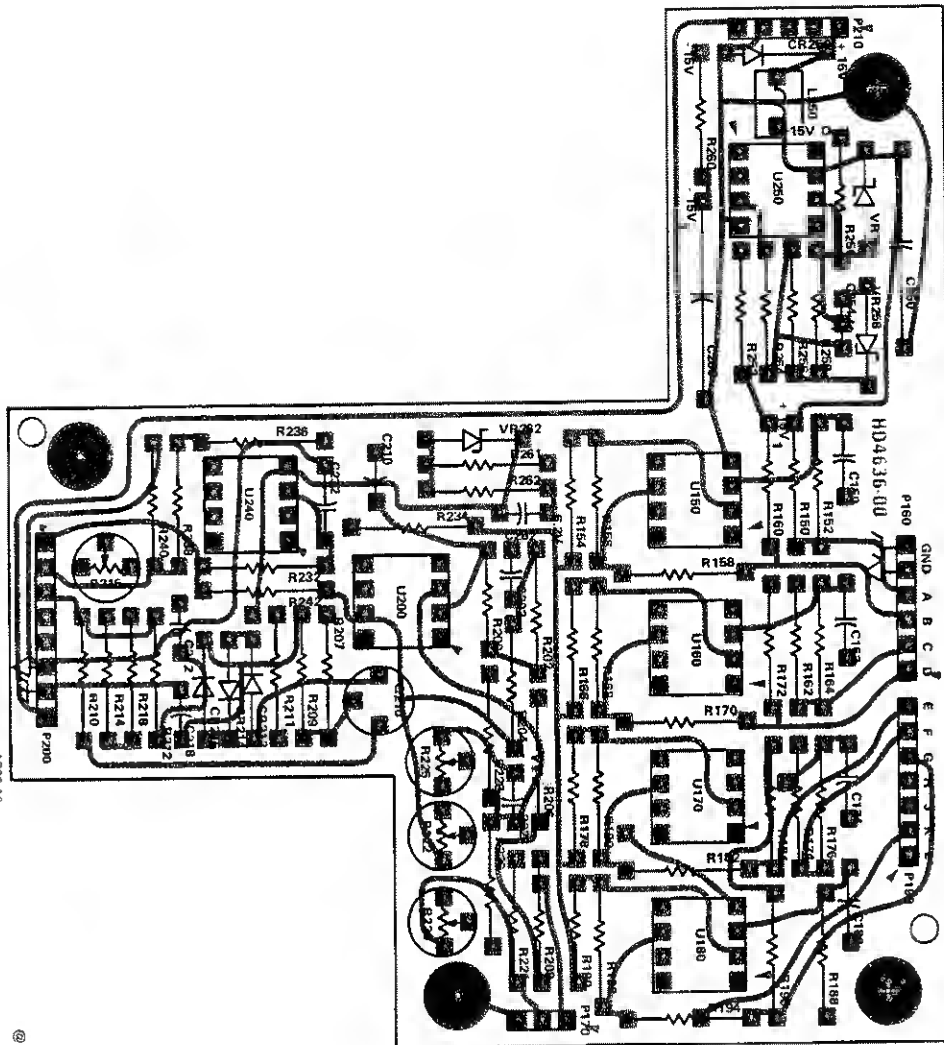






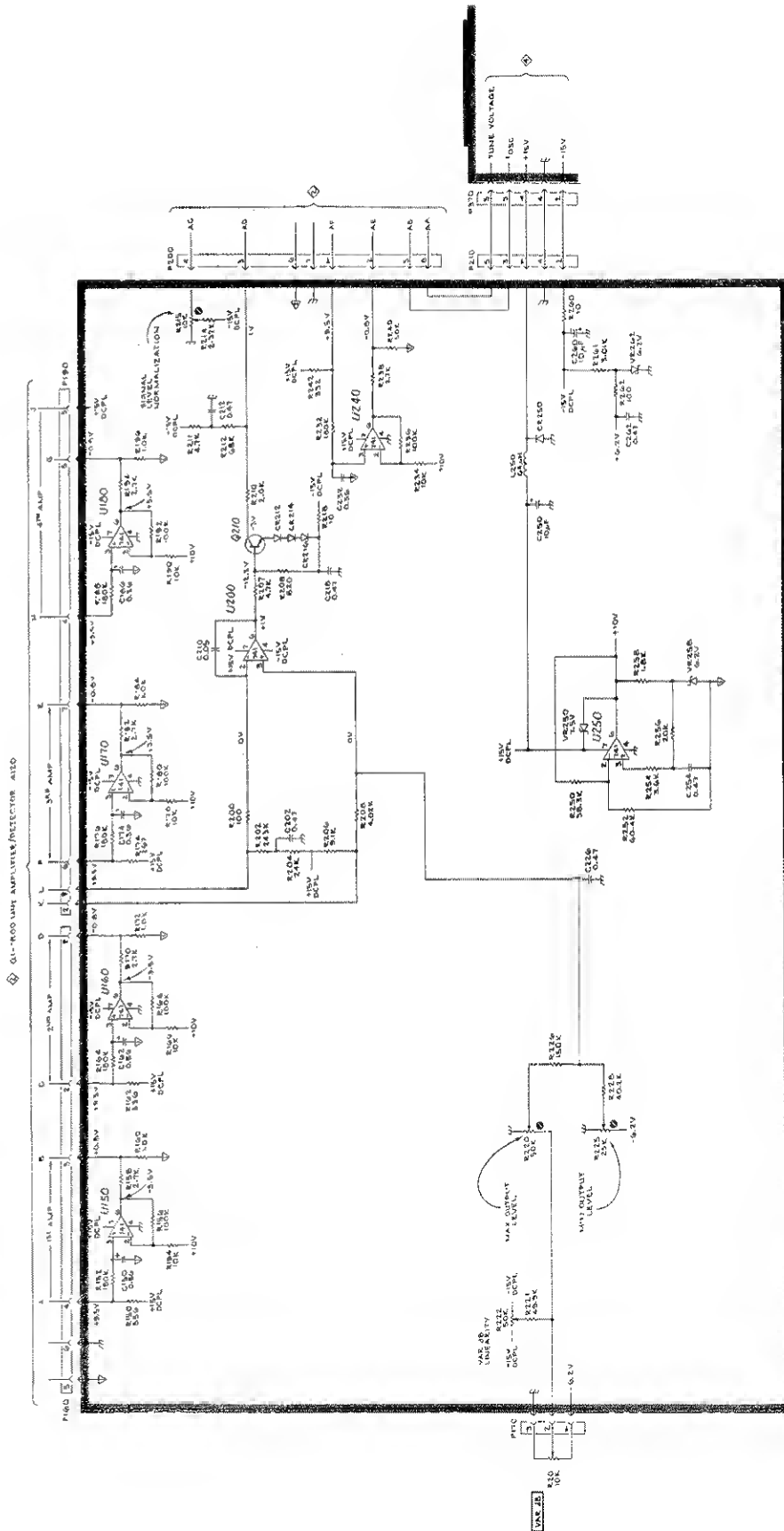
COMPONENT LOCATION  
FOR DIAGRAM 3

TR502









LEVELING LOOP & AMPLIFIER BIAS CIRCUITRY

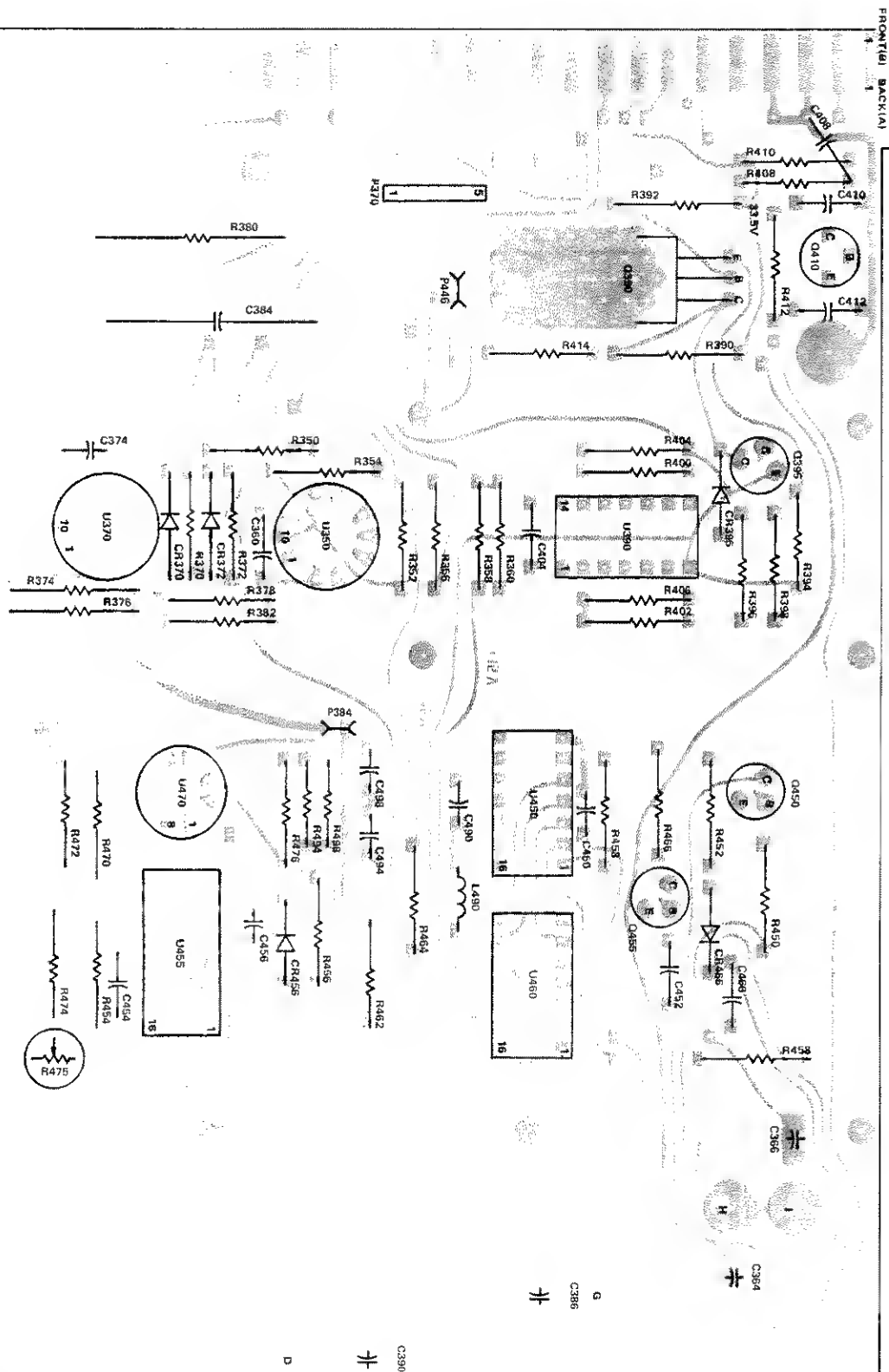
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TR502

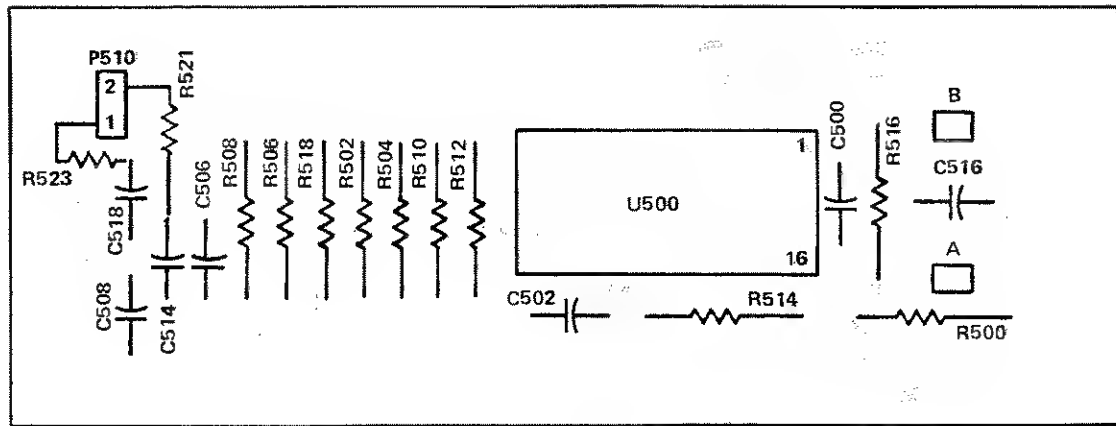






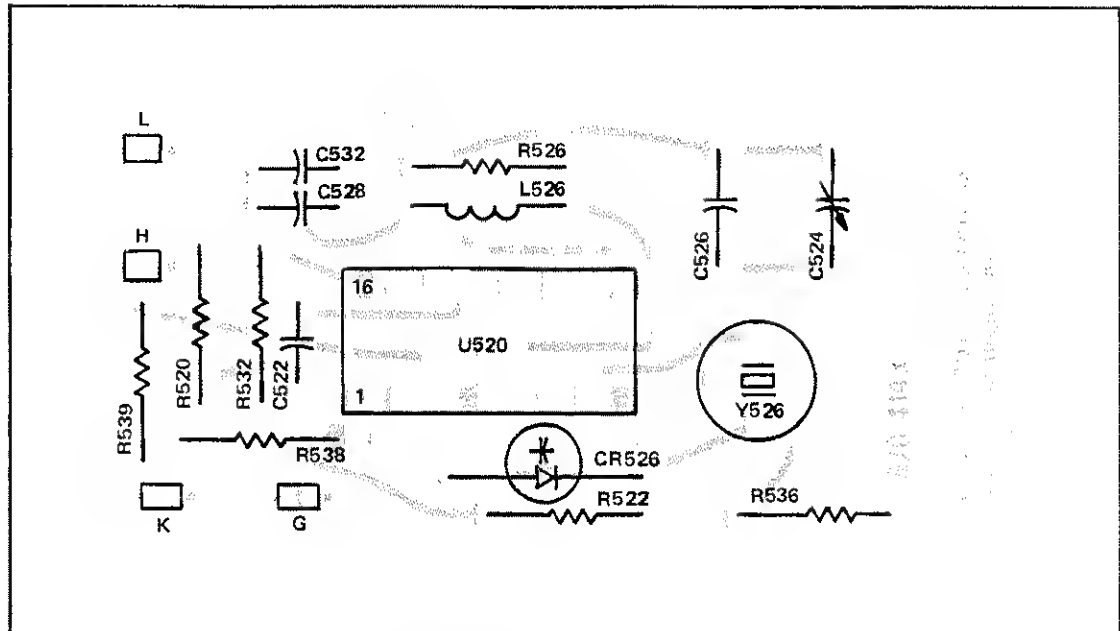






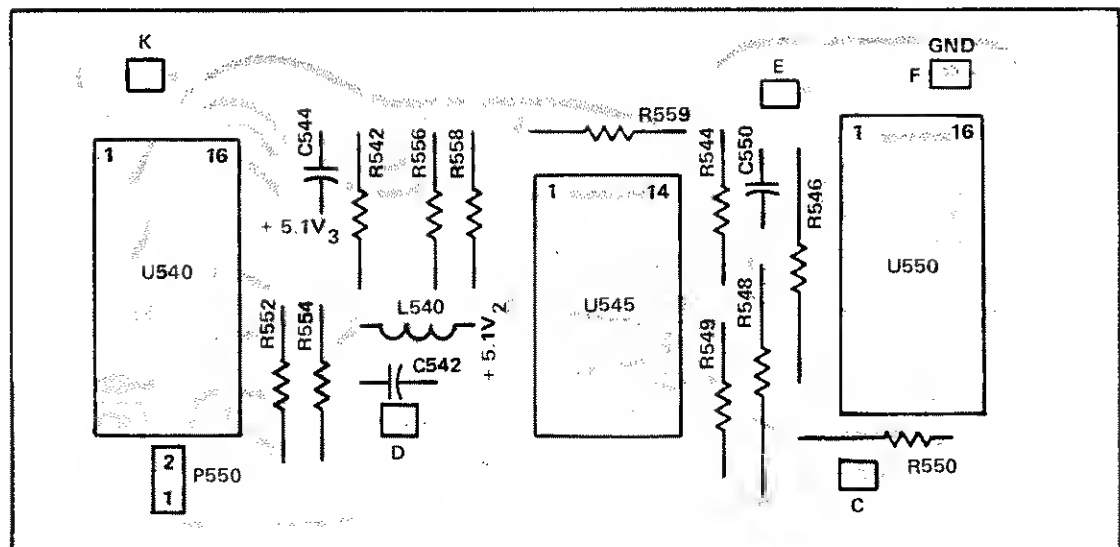
A350A2 105 MHz Amplifier

1735-18



A350A3 52.5 MHz Oscillator

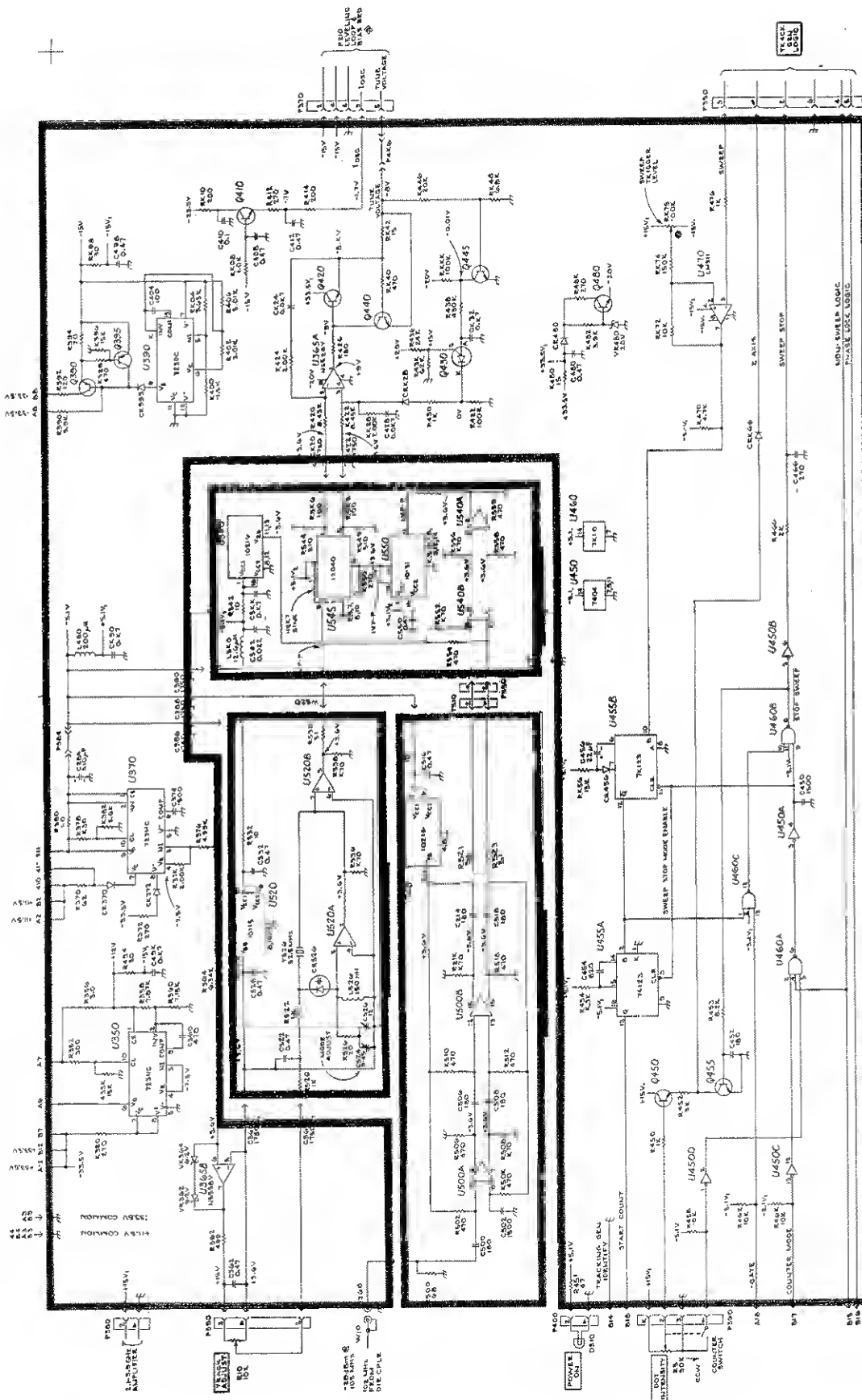
1735-19

A350A4  $\phi/f$  Detector

1735-20







OPERATIONAL LOCK LOGIC, VOLTAGE REGULATOR  
PHASE LOCK CIRCUITRY



# REPLACEABLE MECHANICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number

00X Part removed after this serial number

## FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

## INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```

1 2 3 4 5      Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
    - - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
    - - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
    - - - * - - -
  
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - \* - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U. S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

#	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
ACTR	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ADPTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ALIGN	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
AL	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTEPNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVEING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDNT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

## CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
0000A	LEMO USA	2015 2ND ST.	BERKLEY, CA 94710
00779	AMP, INC.	P. O. BOX 3608	HARRISBURG, PA 17105
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P. O. BOX 5012	DALLAS, TX 75222
06090	RAYCHEM CORP.	300 CONSTITUTION DRIVE	MENLO PARK, CA 94025
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
12327	FREEWAY CORP.	9301 ALLEN DR.	CLEVELAND, OH 44125
18203	ENGELMANN MICROWAVE CO.	SKYLINE DRIVE	MONTVILLE, NJ 07045
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
23499	GAVITT WIRE AND CABLE, DIVISION OF RSC INDUSTRIES, INC.	455 N. QUINCE ST.	ESCONDIDO, CA 92025
45722	USM CORP., PARKER-KALON FASTENER DIV.	1 PEEKAY DRIVE	CLIFTON, NJ 07014
70276	ALLEN MFG. CO.	P. O. DRAWER 570	HARTFORD, CT 06101
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
74445	MOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P. O. BOX 500	BEAVERTON, OR 97077
82647	TEXAS INSTRUMENTS, INC., CONTROL PRODUCTS DIV.	34 FOREST ST.	ATTLEBORO, MA 02703
83309	ELECTRICAL SPECIALITY CO., SUBSIDIARY OF BELDEN CORP.	213 E. HARRIS AVE.	SOUTH SAN FRANCISCO, CA 9408
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
83501	GAVITT WIRE AND CABLE, DIVISION OF RSC INDUSTRIES, INC.	CENTRAL ST.	BROOKFIELD, MA 01506
87308	N. L. INDUSTRIES, INC., SOUTHERN SCREW DIV.	P. O. BOX 1360	STATESVILLE, NC 28677
91836	KINGS ELECTRONICS CO., INC.	40 MARLEDALE ROAD	TUCKAHOE, NY 10707
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK RD.	CHICAGO, IL 60641
98291	SEAELECTRO CORP.	225 HOYT	MAMARONECK, NY 10544

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	337-1399-00		1		SHLD,ELECTRICAL:SIDE	80009	337-1399-00
-2	386-3417-00		1		PLATE,REAR: (ATTACHING PARTS)	80009	386-3417-00
-3	213-0192-00		4		SCR,TPG,THD FOR:6-32 X 0.50 INCH,PNH STL - - - * - - -	B7308	OBD
-4	343-0590-00		2		BLOCK,RETAINER:UPPER (ATTACHING PARTS FOR EACH)	80009	343-0590-00
-5	211-0101-00		2		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL - - - * - - -	83385	OBD
-6	343-0589-00		2		BLOCK,RETAINER:LOWER (ATTACHING PARTS FOR EACH)	80009	343-0589-00
-7	211-0101-00		2		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL - - - * - - -	83385	OBD
-8	-----		1		CABLE ASSY,RF:50 OHM COAX(SEE W10 EPL)		
-9	366-0494-00		1		KNOB:GRAY	80009	366-0494-00
	213-0153-00		1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-10	366-1645-00		1		KNOB:GRAY,FUNCTION ATTENUATOR	80009	366-1645-00
	213-0153-00		2		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-11	210-1011-00		1		WASHER,NONMETAL:0.13 ID X 0.375 " OD,PLSTC	83309	OBD
-12	331-0402-01		1		MASK,DIAL:	80009	331-0402-01
-13	366-1639-00		1		KNOB,GRAY	80009	366-1639-00
	213-0153-00		2		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-14	432-0107-01		1		BASE,KNOB:W/PINS (ATTACHING PARTS)	80009	432-0107-01
-15	210-0586-00		2		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
-16	211-0025-00		2		SCREW,MACHINE:4-40 X 0.375 100 DEG,FLH STL - - - * - - -	83385	OBD
-17	-----		1		RESISTOR,VAR:(SEE R20 EPL) (ATTACHING PARTS)		
-18	210-0583-00		1		NUT,PLAIN,HEX:4-40 X 0.312 INCH,BRS	73743	2X20224-402
-19	210-0940-00		1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL - - - * - - -	79807	OBD
-20	-----		1		CABLE ASSY,RF:ATTEN TO RF OUT(SEE W130 EPL)		
-21	015-1025-01		1		TERM,COAX:3MM MALE 50 OHM,W/CH	18203	T186CS
-22	366-1520-00		1		KNOB:LATCH (ATTACHING PARTS)	80009	366-1520-00
-23	214-1840-00		1		PIN,KNOB SECRG: - - - * - - -	80009	214-1840-00
-24	333-2080-00		1		PANEL,FRONT:LEFT	80009	333-2080-00
-25	214-1513-01		1		LCH,PLUG-IN RET: (ATTACHING PARTS)	80009	214-1513-01
-26	213-0254-00		1		SCR,TPG,THD CTG:2-56X0.25"100 DEG,FLH STL - - - * - - -	45722	OBD
-27	-----		1		AMPTD CONT ASSY:2.095 OSC AMP(SEE A140 EPL) (ATTACHING PARTS)		
-28	211-0100-00		4		SCREW,MACHINE:2-56 X 0.750 INCH,PNH,STL - - - * - - -	83385	OBD
-29	210-0259-00		1		TERMINAL,LUG:0.099"ID INT TOOTH,SE	80009	210-0259-00
-30	-----		1		AMPL/DET ASSY:0.1-18.0 GHZ AMPL(SEE A120 EPL) (ATTACHING PARTS)		
-31	211-0100-00		4		SCREW,MACHINE:2-56 X 0.750 INCH,PNH,STL - - - * - - -	83385	OBD
-32	210-0259-00		1		TERMINAL,LUG:0.099"ID INT TOOTH,SE	80009	210-0259-00
-33	407-1726-00		1		BRACKET,ANGLE:COVER BRACE (ATTACHING PARTS)	80009	407-1726-00
-34	210-0586-00		2		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	OBD
-35	211-0101-00		2		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL - - - * - - -	83385	OBD
-36	-----		1		FILTER,RFI:2.2 GHZ FILTER(SEE A320 EPL) (ATTACHING PARTS)		
-37	211-0008-00		3		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL - - - * - - -	83385	OBD

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-38	386-3403-00			1		SUBPANEL,FRONT:LEFT (ATTACHING PARTS)	80009	386-3403-00
-39	213-0229-00			4		SCR,TPG,THD FOR:6-20 X0.375"100 DEG,FLH STL - - - * - - -	83385	OBD
-40	337-2242-00			1		SHIELD,ELEC:FRONT PANEL,LEFT	80009	337-2242-00
-41	-----			1		CABLE ASSY,RF:1 DB TO 10 DB(SEE W135 EPL)		
-42	-----			1		ATTENUATOR ASSY:0.59 DB,50 OHM(SEE A130 EPL)		
-43	407-1724-00			1		BRKT,SWITCH MTG: (ATTACHING PARTS)	80009	407-1724-00
-44	211-0101-00			2		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL - - - * - - -	83385	OBD
-45	-----			1		CKT BOARD ASSY:LVL LOOP AND BIAS(SEE A150 EPL) (ATTACHING PARTS)		
-46	211-0008-00			4		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL - - - * - - -	83385	OBD
-47	131-0608-00			29		. CKT BOARD ASSY INCLUDES: . CONTACT,ELEC:0.365 INCH LONG	22526	47357
-48	136-0252-04			3		. CONTACT,ELEC:0.188 INCH LONG	22526	75060
-49	136-0514-00			1		. SOCKET,PLUG-IN:MICROCIRCUIT,8 CONTACT	82647	C930802
-50	-----			1		CABLE ASSY,RF:MIXER TO ISOL(SEE W105 EPL)		
-51	-----			1		MIXER ASSEMBLY:OUTPUT(SEE A110 EPL) (ATTACHING PARTS)		
-52	210-0586-00			2		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL - - - * - - -	78189	OBD
-53	441-1297-00			1		CHASSIS,GEN:MAIN LEFT (ATTACHING PARTS)	80009	441-1297-00
-54	211-0101-00			5		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL - - - * - - -	83385	OBD
-55	426-1267-00			1		FRAME SECT,CAB:TOP,LEFT	80009	426-1267-00
-56	426-1270-00			1		FRAME SECT,CAB:BOTTOM,LEFT	80009	426-1270-00
-57	366-0497-01			1		KNOB:GRAY	80009	366-0497-01
-58	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-59	210-0804-00			1		WASHER,FLAT:0.17 ID X 0.375 INCH OD,STL	12327	OBD
-60	348-0093-00			1		GROMMET,RUBBER:0.375 INCH	70485	MOLDCM6368
-61	366-0494-00			1		KNOB:GRAY	80009	366-0494-00
-62	213-0153-00			1		. SETSCREW:5-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-63	-----			1		RESISTOR,VAR:(SEE R10 EPL) (ATTACHING PARTS)		
-64	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-65	210-0940-00			2		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL - - - * - - -	79807	OBD
-66	-----			1		RESISTOR,VAR:(SEE R5 EPL) (ATTACHING PARTS)		
-67	210-0583-00			1		NUT,PLAIN,HEX:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-68	210-0940-00			1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL - - - * - - -	79807	OBD
-69	131-1471-00			1		CONNECTOR,RCPT:	0000A	RA1306
-70	333-2081-00			1		PANEL,FRONT:RIGHT	80009	333-2081-00
-71	644-0065-00			1		HONEY COMB ASSY: (ATTACHING PARTS)	80009	644-0065-00
-72	211-0510-00			4		SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL - - - * - - -	83385	OBD
-73	337-2250-00			1		. SHIELD,ELEC (ATTACHING PARTS)	80009	337-2250-00
-74	211-0087-01			17		. SCREW,MACHINE:2-56 X 0.188" 82 DEG,FLH,STL - - - * - - -	83385	OBD
-75	-----			1		. CKT BOARD ASSY:105 MHZ AMP(SEE A350A2 EPL) (ATTACHING PARTS)		
-76	211-0162-00			4		. SCREW,CAP:2-56 X 0.188 INCH,SCH SST - - - * - - -	70276	OBD
-77	-----			-		. . CKT BOARD ASSY INCLUDES:		
-78	131-1425-00			1		. . CONTACT SET,ELE:R ANGLE,0.150" L	22526	65275-001
-79	136-0263-04			2		. . CONTACT,ELEC:FOR 0.025 INCH SQUARE PIN	22526	75377-001

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-76	136-0260-02		1	.	SOCKET, PLUG-IN: 16 CONTACT, LOW CLEARANCE	01295	C931602
-77	214-2342-00		1	.	HEAT SINK: MICROCIRCUIT (ATTACHING PARTS)	80009	214-2342-00
-78	211-0159-00		2	.	SCREW, MACHINE: 2-56 X 0.375 INCH, PNH STL - - - * - - -	83385	OBD
-79	131-0594-00		1	.	CONTACT, ELEC: FEEDTHRU, 1.485 INCH LONG	22526	47356
-80	162-0026-00		FT	.	INS, SLV, ELEC: BULK, 0.58 INCH OD	06090	OBD
-81	-----		1	.	CKT BOARD ASSY: FRED DET (SEE A350A4 EPL)		
-82	131-1425-00		1	.	CONTACT SET, ELE: R ANGLE, 0.150" L	22526	65275-001
-83	136-0263-04		5	.	CONTACT, ELEC: FOR 0.025 INCH SQUARE PIN	22526	75377-001
-84	136-0260-02		2	.	SOCKET, PLUG-IN: 16 CONTACT, LOW CLEARANCE	01295	C931602
-85	136-0252-04		14	.	CONTACT, ELEC: 0.188 INCH LONG	22526	75060
-86	-----		1	.	CKT BOARD ASSY: 52.5 MHZ OSC (SEE A350A3 EPL) (ATTACHING PARTS)		
-87	211-0162-00		4	.	SCREW, CAP: 2-56 X 0.188 INCH, SCH SST - - - * - - -	70276	OBD
-88	136-0260-02		1	.	SOCKET, PLUG-IN: 16 CONTACT, LOW CLEARANCE	01295	C931602
-89	136-0252-04		3	.	CONTACT, ELEC: 0.188 INCH LONG	22526	75060
-90	136-0263-04		4	.	CONTACT, ELEC: FOR 0.025 INCH SQUARE PIN	22526	75377-001
-91	337-1912-00		1	.	SHIELD, ELEC: HONEYCOMB (ATTACHING PARTS)	80009	337-1912-00
-92	211-0162-00		17	.	SCREW, CAP: 2-56 X 0.188 INCH, SCH SST - - - * - - -	70276	OBD
-93	-----		1	.	CKT BOARD ASSY: MOTHER (SEE A350A1 EPL)		
-94	136-0252-04		51	.	CONTACT, ELEC: 0.188 INCH LONG	22526	75060
-95	131-0993-00		2	.	LINK, TERM. CONNE: 2 WIRE BLACK	00779	530153-2
-96	131-0608-00		27	.	CONTACT, ELEC: 0.365 INCH LONG	22526	47357
-97	-----		1	.	TRANSISTOR: (SEE Q390 EPL) (ATTACHING PARTS)		
-98	210-0406-00		1	.	NUT, PLAIN, HEX.: 4-40 X 0.188 INCH, BRS	73743	2X12161-402
-99	211-0007-00		1	.	SCREW, MACHINE: 4-40 X 0.188 INCH, PNH STL - - - * - - -	83385	OBD
-100	136-0260-02		1	.	SOCKET, PLUG-IN: 16 CONTACT, LOW CLEARANCE	01295	C931602
-101	136-0269-02		3	.	SOCKET, PLUG-IN: 14 CONTACT, LOW CLEARANCE	01295	C931402
-102	131-1729-00		1	.	CONN, RCPT, ELEC: SMB SNAP-ON	98291	051-051-0219-1
-103	-----		1	.	TRANSISTOR: (SEE Q420 EPL) (ATTACHING PARTS)		
-104	210-0407-00		2	.	NUT, PLAIN, HEX.: 6-32 X 0.25 INCH, BRS	73743	3038-0228-402
-105	211-0507-00		2	.	SCREW, MACHINE: 6-32 X 0.312 INCH, PNH STL	83385	OBD
-106	210-0801-00		6	.	WASHER, FLAT: 0.14 ID X 0.281 OD NP STL - - - * - - -	12327	OBD
-107	131-0593-00		7	.	CONTACT, ELEC: 1.15 INCH LONG	22526	47354
-108	281-0752-00		7	.	CAP., FXD, CER DI: 1750PF	80009	281-0752-00
-109	136-0514-00		1	.	SOCKET, PLUG-IN: MICROCIRCUIT, 8 CONTACT	82647	C930802
-110	131-0787-00		1	.	CONTACT, ELEC: 0.64 INCH LONG	22526	47359
-111	200-0935-00		1	.	BASE, LAMPHOLDER: 0.29 OD X 0.19 CASE	80009	200-0935-00
-112	378-0602-00		1	.	LENS, LIGHT: GREEN	80009	378-0602-00
-113	352-0157-00		1	.	LAMPHOLDER: WHITE PLASTIC	80009	352-0157-00
-114	-----		1	.	AMPLIFIER: 2.1-3.9 GHZ (SEE A60 EPL) (ATTACHING PARTS)		
-115	210-0586-00		2	.	NUT, PLAIN, EXT W: 4-40 X 0.25 INCH, STL - - - * - - -	78189	OBD
-116	210-0202-00		1	.	TERMINAL, LUG: SE #6 (ATTACHING PARTS)	78189	2104-06-00-2520N
-117	210-0586-00		1	.	NUT, PLAIN, EXT W: 4-40 X 0.25 INCH, STL - - - * - - -	78189	OBD
-118	386-3405-00		1	.	SUBPANEL, FRONT: RIGHT (ATTACHING PARTS)	80009	386-3405-00
-119	213-0229-00		4	.	SCR, TPG, THD FOR: 6-20 X 0.375" 100 DEG, FLH STL - - - * - - -	83385	OBD
-120	337-2241-00		1	.	SHIELD, ELEC: FRONT PANEL, LEFT	80009	337-2241-00
-121	-----		1	.	CABLE ASSY, RF: BANDPASS TO LP (SEE W85 EPL)		
-122	-----		1	.	CABLE ASSY, RF: BANDPASS TO ISOL (SEE W95 EPL)		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-123	-----	-----	1		CABLE ASSY, RF: LOWPASS TO ISOL (SEE W75 EPL)		
-124	210-0938-00		1		WASHER, FLAT: 0.109 ID X 0.250 INCH OD	75497	AN960-3
-125	343-0013-00		1		CLAMP, LOOP: 0.375 INCH DIA	95987	3-8-6B
-126	-----	-----	1		FILTER, LOW PASS: 4.5 GHZ (SEE A80 EPL)		
-127	-----	-----	1		ISOLATOR, RF REF: 2.4 GHZ (SEE A70 EPL)		
					(ATTACHING PARTS)		
-128	211-0008-00		3		SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL	83385	OBD
					-----*		
-129	-----	-----	1		ISOLATOR, RF REF: 2.4 GHZ (SEE A100 EPL)		
					(ATTACHING PARTS)		
-130	211-0008-00		3		SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL	83385	OBD
					-----*		
-131	-----	-----	1		BANDPASS FILTER: 2.1-3.9 FHZ (SEE A90 EPL)		
					(ATTACHING PARTS)		
-132	211-0008-00		4		SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL	83385	OBD
					-----*		
-133	441-1296-00		1		CHASSIS, GEN: MAIN, RIGHT	80009	441-1296-00
					(ATTACHING PARTS)		
-134	211-0101-00		8		SCREW, MACHINE: 4-40 X 0.25" 100 DEG, FLH STL	83385	OBD
					-----*		
-135	426-1268-00		1		FRAME SECT, CAB: TOP RIGHT	80009	426-1268-00
-136	426-1269-00		1		FRAME SECT, CAB: BOTTOM RIGHT	80009	426-1269-00
-137	131-0707-00		37		CONTACT, ELEC: 0.48"L, 22-26 AWG WIRE	22526	47439
-138	352-0169-00		1		CONN BODY, PL, EL: 2 WIRE BLACK	80009	352-0169-00
	352-0169-01		1		CONN BODY, PL, EL: 2 WIRE BROWN	80009	352-0169-01
	352-0169-02		1		CONN BODY, PL, EL: 2 WIRE RED	80009	352-0169-02
-139	352-0161-03		1		CONN BODY, PL, EL: 3 WIRE ORANGE	80009	352-0161-03
	352-0161-07		1		CONN BODY, PL, EL: 3 WIRE VIOLET	80009	352-0161-07
-140	352-0162-04		1		CONN BODY, PL, EL: 4 WIRE YELLOW	80009	352-0162-04
-141	352-0163-05		2		CONN BODY, PL, EL: 5 WIRE GREEN	80009	352-0163-05
-142	352-0164-00		1		CONN BODY, PL, EL: 6 WIRE BLACK	80009	352-0164-00
	352-0164-05		1		CONN BODY, PL, EL: 6 WIRE GREEN	80009	352-0164-05
-143	352-0165-09		1		CONN BODY, PL, EL: 7 WIRE WHITE	80009	352-0165-09
-144	352-0166-08		1		CONN BODY, PL, EL: 8 WIRE GRAY	80009	352-0166-08
-145	175-0825-00		FT		WIRE, ELECTRICAL: 2 WIRE RIBBON	23499	TEK-175-0825-00
-146	175-0826-00		FT		WIRE, ELECTRICAL: 3 WIRE RIBBON	08261	TEK-175-0826-00
-147	175-0828-00		FT		WIRE, ELECTRICAL: 5 WIRE RIBBON	23499	TEK-175-0828-00
-148	175-0829-00		FT		WIRE, ELECTRICAL: 6 WIRE RIBBON	83501	TEK-175-0829-00



TR 502 TRACKING GENERATOR

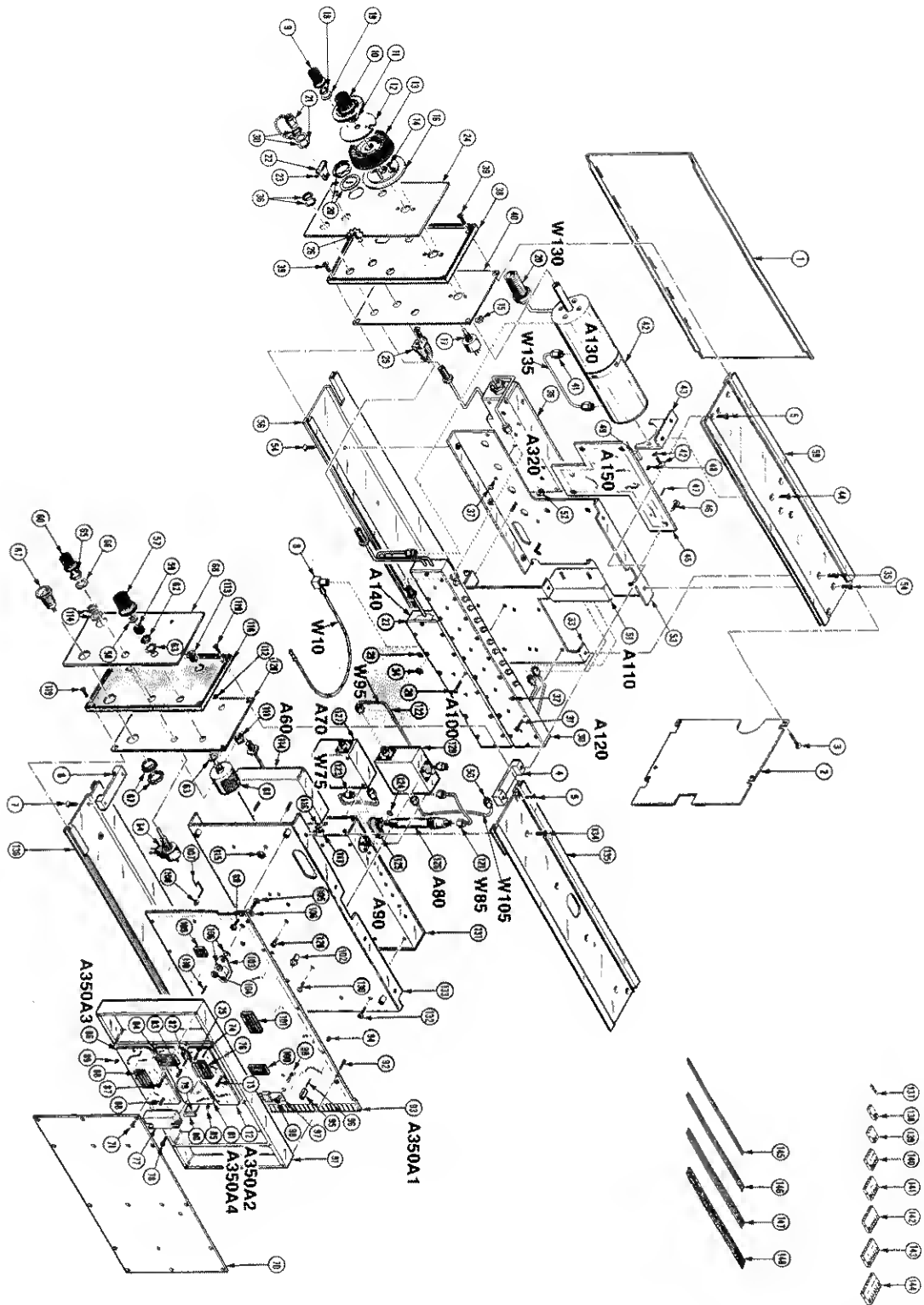
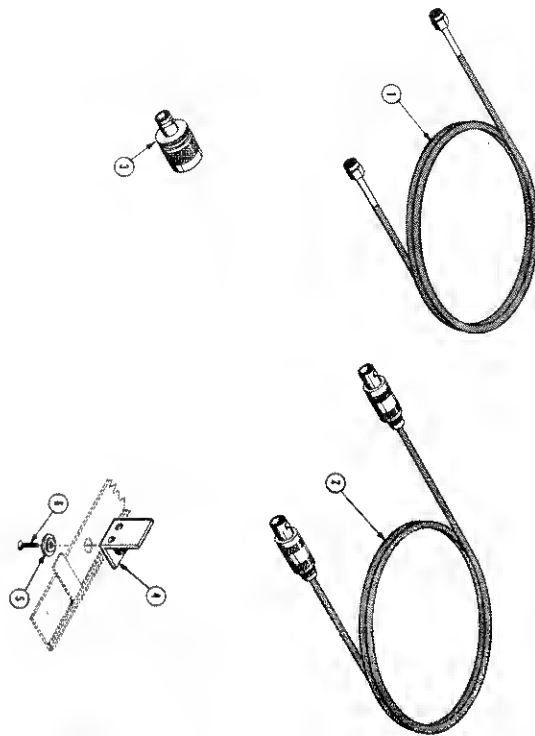


FIG. 1 EXPLODED



FIG. 2 ACCESSORIES  
& REPACKAGING

ACCESSORIES



REPACKAGING

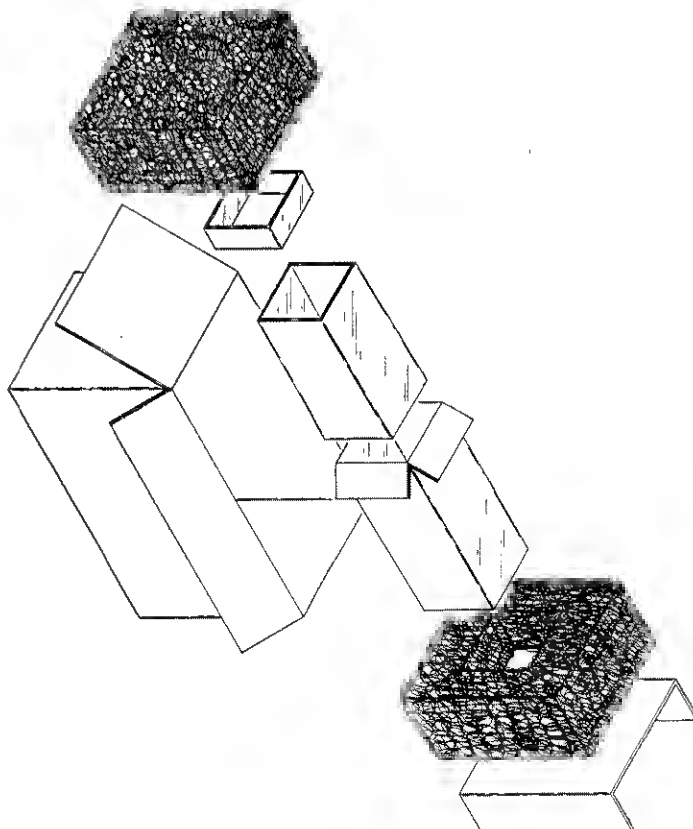


Fig. 2  
Index

No.	Tektronix Serial/Model No.	Qty	Name & Description	Mfr Code	Mfr Part Number
-1	012-0649-00	2	CABLE ASBY, RF, 50 OHM COAX, 28.5 INCH LONG	80009	012-0649-00
-2	012-0648-00	1	CABLE ASBY, SF, 29.5 INCH LONG	80009	012-0648-00
-3	103-0045-00	1	ADAPTER, COAX, TYPE, N MALE, BNC MALE	91836	8099-3578
-4	343-0604-00	1	RETAINER, PL, IN	80009	343-0604
-5	210-1248-00	1	NUTS, SMLDR, 0.12 ID X 0.5 OD, SST	80009	210-124
-6	211-0025-00	1	SCREW, MACHINE, 4-40 X 0.375 100 DPT, FTM STL	83385	CMO
	070-1735-00	1	MANUAL, TECH, INSTRUCTION	80009	070-173

CH No.	Tektronix Serial/Model No.	Qty	Name & Description	Mfr Code	Mfr Part Number
065-0201-00			CARTON ASSY:	80009	065-0201-00



## **MANUAL CHANGE INFORMATION**

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

## **SERVICE NOTE**

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

# CALIBRATION TEST EQUIPMENT REPLACEMENT

## Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 nsec into 50 $\Omega$ .	107 - Risetime less than 3.0 nsec into 50 $\Omega$ .
108	PG 501 - 5 V output pulse; 3.5 nsec Risetime.	108 - 10 V output pulse; 1 nsec Risetime.
111	PG 501 - Risetime less than 3.5 nsec; 8 nsec Pretrigger pulse delay.	111 - Risetime 0.5 nsec; 30 to 250 nsec Pretrigger Pulse delay.
114	PG 501 - $\pm 5$ V output.	114 - $\pm 10$ V output. Short proof output.
115	PG 501 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; $\pm 5$ V dc Offset; short proof output. Has $\pm 5$ V output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; $\pm 10$ V output. Short proof output.
PG 502 replaces 107	PG 502 - 5 V output	108 - 10 V output.
108	PG 502 - Risetime less than 1 nsec; 10 nsac Pretrigger pulse delay.	111 - Risetime 0.5 nsec; 30 to 250 nsec Pretrigger pulse delay.
111	PG 502 - $\pm 5$ V output.	114 - $\pm 10$ V output. Short proof output.
114	PG 502 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; $\pm 5$ V output. Short proof output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; $\pm 10$ V output. Short proof output.
115	PG 502 - Does not have Paired, Delayed, Undelayed and output locked mode; $\pm 5$ V output.	2101 - Paired, Delayed, Undelayed and output locked on mode; 10 V output.
2101		
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude, 60 V output.	106 - Positive and Negative-going trigger output signal, 50 nsec and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191	SG 503 - Frequency range 250 kHz to 250 MHz.	191 - Frequency range 350 kHz to 100 MHz.
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180, 180A	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. Only one time-mark can be generated.	180A - Marker outputs, 5 sec to 1 $\mu$ s. Sinewave available at 5, 10, and 50 MHz. Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be stacked.
181	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns.	181 - Marker outputs, 1, 10, 100, 1000, and 10,000, plus 10 MHz sinewave.
2901	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available only at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. Only one time-mark can be generated.	2901 - Marker outputs, 5 sec to 0.1 $\mu$ s. Sinewave available at 5, 10, and 50 ns. Separate trigger pulses, from 5 sec to 0.1 $\mu$ s. Multiple time-marks can be stacked.



